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Report

FINAL
SAMPLING AND ANALYSIS PLAN
OMEGA CHEMICAL SUPERFUND SITE
PHASE 1a FIELD INVESTIGATION

WHITTIER, CALIFORNIA
LOS ANGELES COUNTY, CALIFORNIA

FINAL
SAMPLING AND ANALYSIS PLAN
OMEGA CHEMICAL SUPERFUND SITE
PHASE 1a FIELD INVESTIGATION

WHITTIER, CALIFORNIA
LOS ANGELES COUNTY, CALIFORNIA

Submitted to:

U.S. Environmental Protection Agency
Region IX

Prepared for:

Omega Chemical Site PRP Organized Group

Prepared by:

Camp Dresser & McKee Inc.
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April 23, 1999



Camp Dresser & McKee Inc.

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April 23, 1999

Mr. Craig Cooper
Superfund Division (SFD)
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, California 94105-3901

Subject: Submittal of Final Sampling and Analysis Plan
Omega Chemical Superfund Site
CDM Project No. 10500-24699-T3.SAP
CDM File No. 10500-5.5.2

Dear Mr. Cooper:

On behalf of the Omega Chemical Site PRP Organized Group (OPOG) and in accordance with EPA correspondence dated April 12, 1999, Camp Dresser & McKee Inc. (CDM) is herein submitting four copies of the Final Phase 1a Field Investigation Sampling and Analysis Plan (SAP).

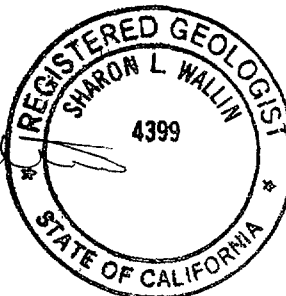
Please feel free to contact Chuck McLaughlin or me if you have any questions.

Sincerely,

CAMP DRESSER & MCKEE INC.

Sharon L. Wallin

Sharon L. Wallin, R.G.
Principal Investigator



Attachment

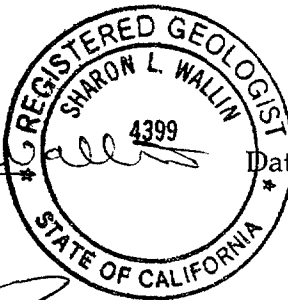
cc: Chuck McLaughlin, *de maximis, inc.*
Dave Chamberlin, CDM

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Prepared by:

Sharon L. Wallin
Sharon L. Wallin, R.G.
Principal Investigator



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4/23/99

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4/23/99

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Approved by:

Chuck McLaughlin
Chuck McLaughlin
Project Coordinator

Date:

4/23/99

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Section 1

Introduction

On behalf of the Omega Chemical Site PRP Organized Group (OPOG), Camp Dresser & McKee Inc. (CDM) has prepared this Sampling and Analysis Plan (SAP) for the Partial Phase 1 Investigation (Phase 1a) of the Omega Chemical Superfund Site (site). This investigation is being performed in accordance with Task 21(h) of existing USEPA Order 95-15. The purpose of the program, background of the site, and scope of work are detailed below.

1.1 Purpose

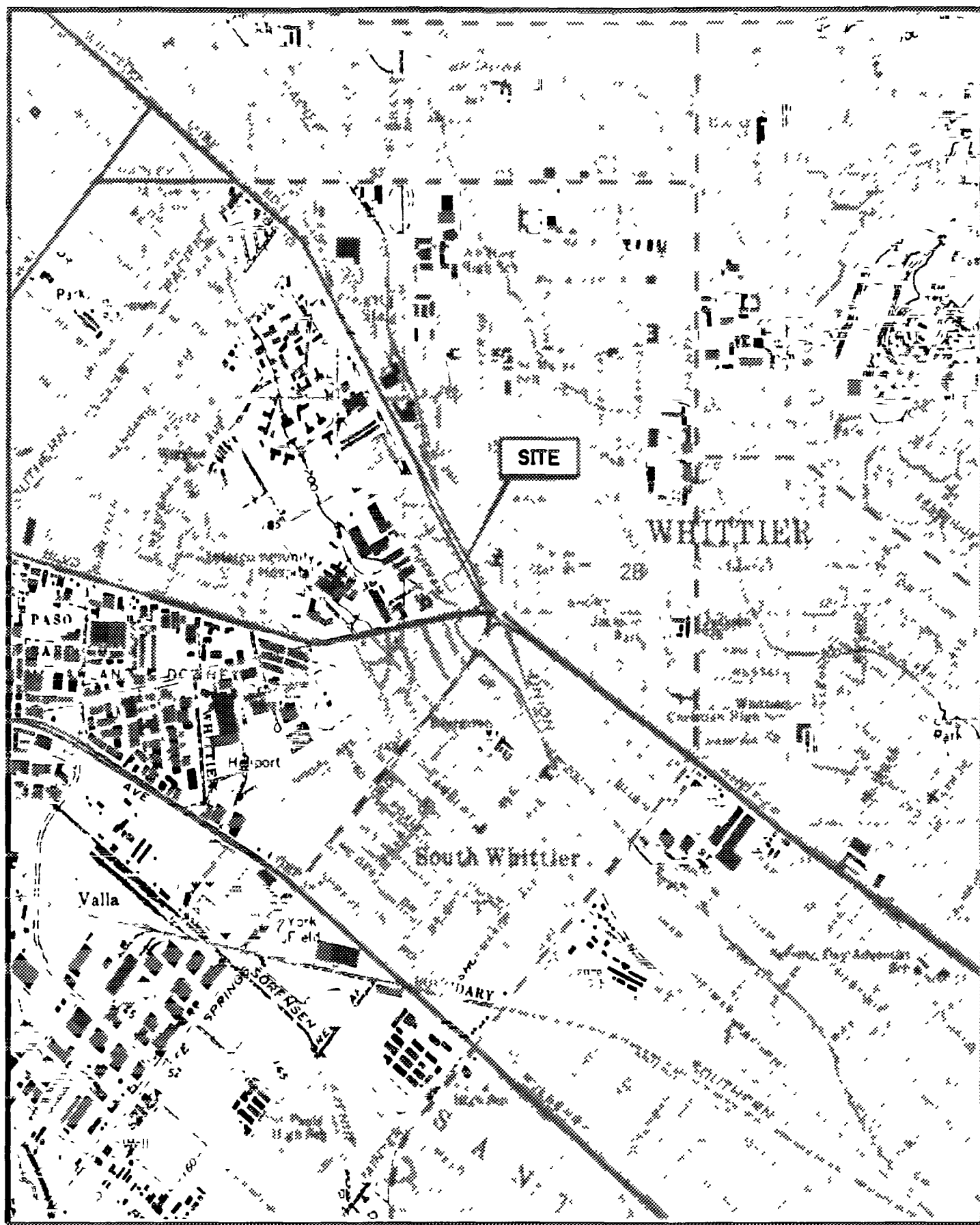
The purpose of this work is to collect groundwater information at and immediately downgradient of the site and, in parallel, begin the process of identifying Applicable or Relevant and Appropriate Requirements (ARARs) and evaluating the nature and extent of any risks posed by known or suspected contamination. With respect to the groundwater investigation, the proposed work is intended to (a) provide additional data regarding the vertical distribution of contaminants directly beneath the site, (b) collect sufficient piezometric and hydraulic data to better define the groundwater flow direction and potential rate of flow, and (c) establish permanent monitoring points which may be used during design and operation of an appropriate remedy to address the near-site groundwater contamination. The parallel ARARs identification and risk evaluation will be used, in part, to assist in assessing whether additional data collection will be required in order to select and design an appropriate remedy. Such additional data collection could be conducted under Phase 1b investigation, and could include additional on-site soils information (soil matrix and/or vapor phase), or additional groundwater quality information. Specific recommendations for additional data collection, if required, will be provided as a part of the investigation summary report.

1.2 Background

Omega Chemical Site

The Omega Chemical site is located at 12504 East Whittier Boulevard in Whittier, California (see Figures 1-1 and 1-2 for site location and vicinity maps). The facility reportedly operated as a RCRA spent solvent and refrigerant recycling and treatment facility, handling primarily chlorinated hydrocarbons and chlorofluoro-carbons from approximately 1976 to 1991. Drums and bulk loads of waste solvents and chemicals from various industrial activities were processed to form commercial products which were returned to generators or sold in the marketplace. Chemical, thermal, and physical treatment processes were reportedly used to recycle and reuse the waste materials. Wastes generated from these treatment and recycling activities included still bottoms, aqueous fractions, and non-recoverable solvents.

Soil gas, soil, and groundwater investigations were performed by a variety of consultants to Omega between 1985 and 1988. Following issuance of Administrative Order 95-15 to PRPs by the U.S. Environmental Protection Agency (EPA) on May 9, 1995, work involving the removal of a large number of drums, containers, and debris, plus decontamination of the surface of the site, was



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SITE LOCATION MAP

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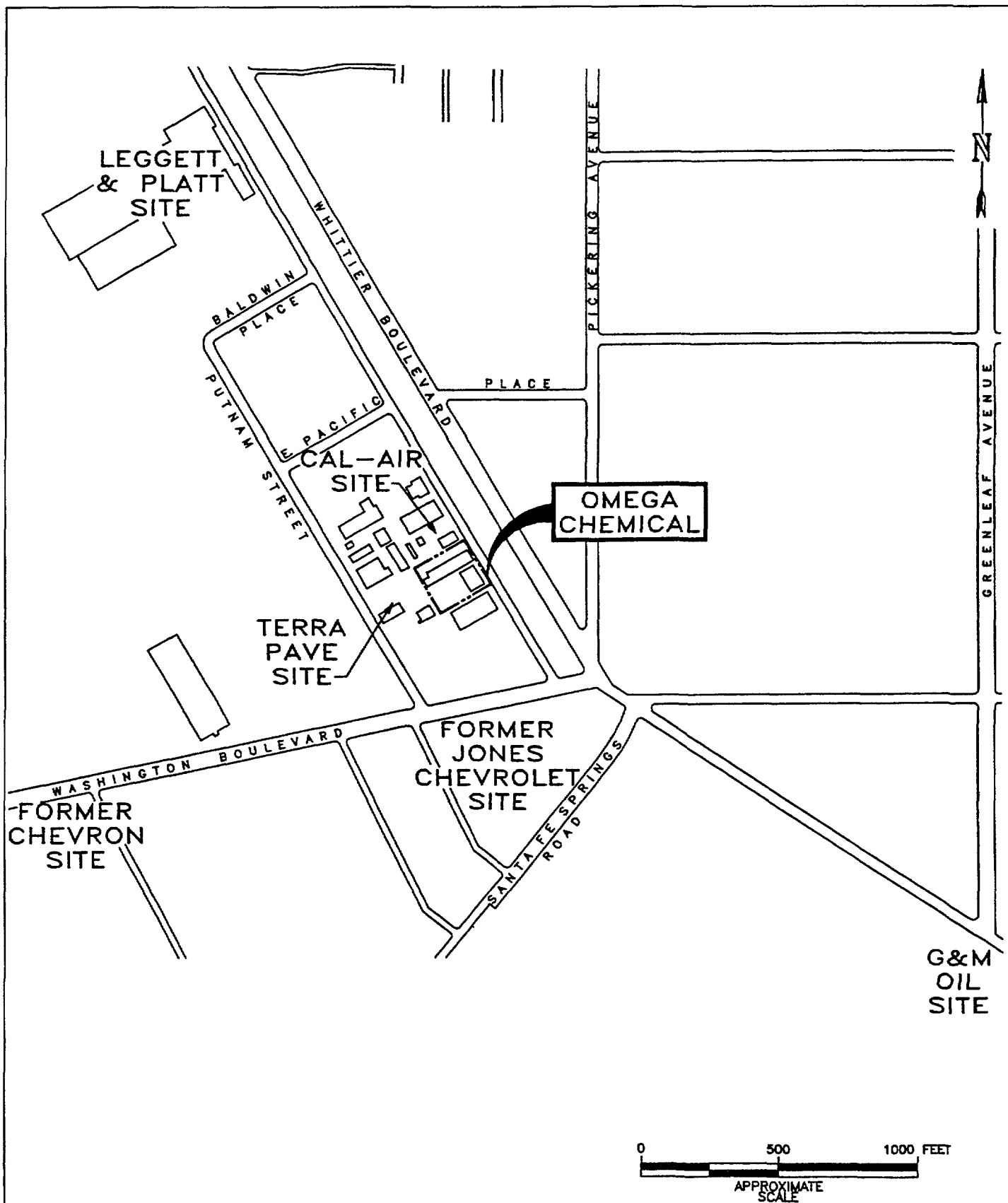
Figure 1-1

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FIG. 1-1



SOURCE: England & Associates and Hargis + Associates, Inc.

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VICINITY MAP

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Figure 1-2

completed in September 1995. Phase II field activities commenced in November 1995. This work included:

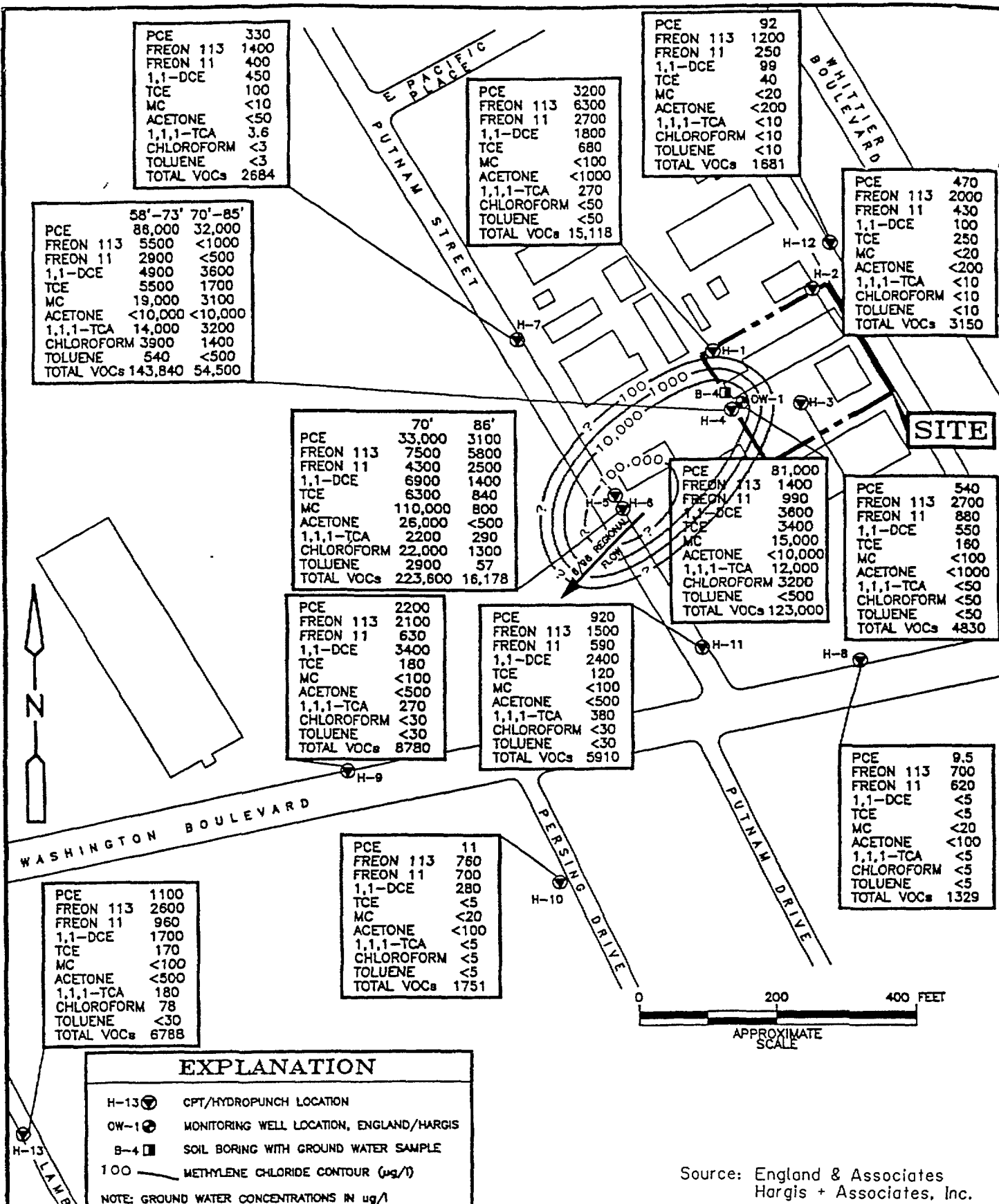
- Location and evaluation of previous groundwater monitoring well BMW-1
- A shallow soil gas survey
- Collection of stormwater
- Shallow soil sampling and analysis
- Removal/treatment of contaminated near-surface materials
- On-site deep soil and groundwater investigation (CPT/HydroPunch™ and installation of well OW1 to 80 feet below ground surface)
- Soil vapor extraction test.

Additionally, off-site CPT/HydroPunch™ groundwater investigations were conducted in July 1996 (H-6 through H-13) and in March 1997 (H-14 through H-17) to characterize and define the downgradient extent of the VOC groundwater plume. The results of the March 1997 off-site investigation were summarized in Technical Memorandum No. 11 A (C2 REM, April 30, 1997), which concluded that elevated levels of volatile organic compounds (VOCs) were present in groundwater further downgradient than expected based on groundwater modeling results. The site is located in an industrialized area where VOCs have been detected upgradient and downgradient of other industrial facilities. It is likely that the elevated VOCs detected down-gradient from the Omega site are the result of several commingled VOC plumes derived from currently unidentified properties other than Omega. Figures 1-3 and 1-4 illustrate the concentrations of VOCs detected in the groundwater during the CPT/HydroPunch™ investigations.

Geology and Hydrogeology

The site is underlain by low permeability silty and clayey soils to a depth of at least 120 feet. No transmissive aquifer was found immediately beneath the facility. Groundwater beneath the facility occurs approximately 70 feet below ground surface (bgs) within low permeability silt and clay. A coarse-grained sandy layer, probably representing the Gage aquifer, was encountered southwest of the site along Putnam Street, but was not detected beneath the site. Figure 1-5 shows a geologic cross-section in the vicinity of the Omega site. The hydraulic conductivity in the fine-grained materials beneath the Omega site is as much as two to three orders of magnitude lower than in the coarser materials found beneath a former Chevron site located approximately 1,500 feet southwest of the site.

The direction of regional groundwater flow is generally to the southwest, with a hydraulic gradient of 0.0125 beneath the site, flattening to 0.0015 in the coarser sediments southwest of the site. Regional flow direction is illustrated on Figure 1-2. Local flow direction is currently unknown and is assumed to be comparable to the regional direction. The nearest active downgradient water supply wells are located more than one mile from the site. Screened intervals for these wells begin 200 feet or more bgs, and at least two aquitards appear to be present between the shallowest aquifer and the top of the well screen in these wells. The shallow groundwater beneath the site does not appear to be suitable for municipal or domestic water supply based on Total Dissolved Solids (TDS) concentrations exceeding 3,000 mg/l.



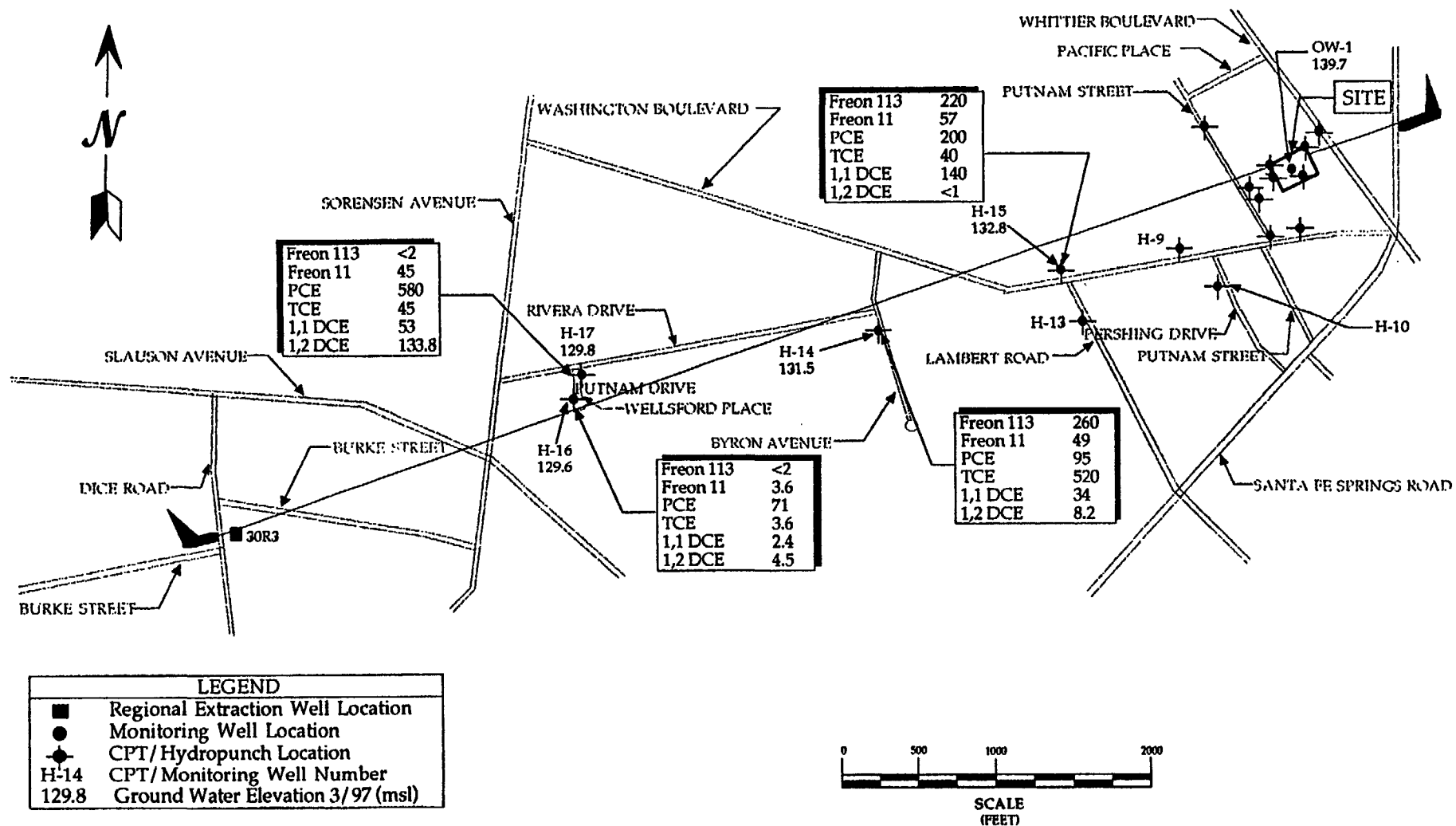
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SUMMARY OF GROUNDWATER CHARACTERIZATION IN THE VICINITY OF THE OMEGA SITE

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Figure 1-3



SOURCE: Figure 1, Technical memorandum no. 11A, 2 REM, April 30, 1997.

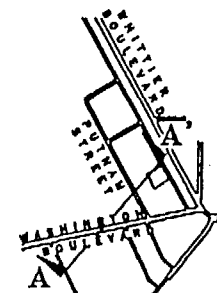
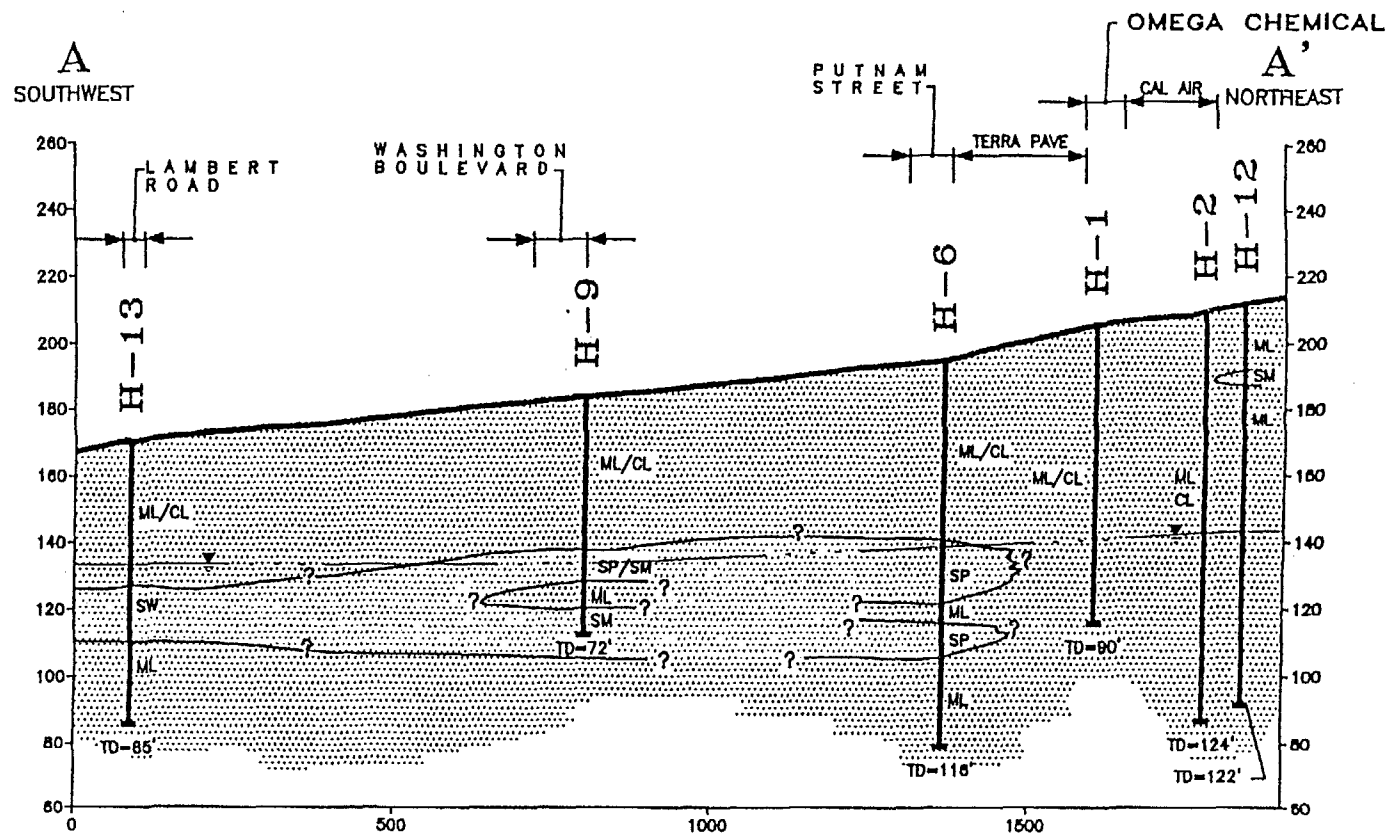
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ANALYTICAL RESULTS FROM CPT/HYDROPUNCH GROUND WATER INVESTIGATION

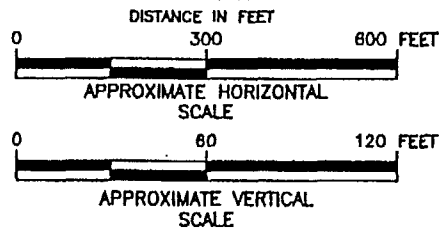
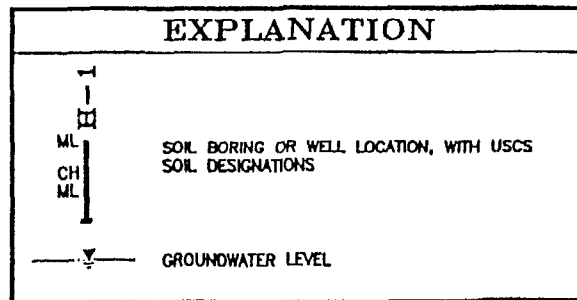
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Figure 1-4



CROSS SECTION LOCATION



Source: England & Associates
Hargis + Associates, Inc.

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CROSS-SECTION IN THE VICINITY OF THE OMEGA SITE

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Figure 1-5

1.3 Scope of Work

Phase 1a activities include the following work elements:

- Collection of lithologic samples during drilling,
- Collection and archiving of split-spoon soil samples from the OW1b boring for possible future DNAPL (dense non-aqueous phase liquid) and physical property (e.g., bulk density, porosity, total organic carbon, etc.) testing,
- Monitoring well installations (three wells),
- Step-drawdown testing of the newly-installed wells,
- Collection of water quality and water level data from the newly-installed and existing wells,
- Review and analysis of new data,
- Disposal of investigation derived waste (IDW), and
- Contaminant transport modeling.

It should be noted that the scope of work outlined above is for the Phase 1 a investigation only. As previously discussed in Section 1.1 of this document, specific recommendations for additional data collection, if required, will be provided in the Phase 1a investigation summary report. Routine groundwater monitoring and a broader range of one-time groundwater testing may also be proposed for subsequent investigatory phases.

1.4 EPA Notification

EPA will be provided with 10 days written notice prior to the initiation of Phase 1a field activities. EPA will also be notified of any planned deviations from the SAP; significant deviations will not be performed without EPA's prior approval. With respect to deviations necessitated by field conditions which require an immediate response and result in a modification to the SAP, EPA will be notified of the deviation within 24 hours and will be provided with the rationale for the modification.

During the performance of the field program, brief status reports will be transmitted to EPA via e-mail on an approximate weekly basis. The status reports will summarize tasks completed during the prior week, tasks anticipated for the upcoming week, deviations from the SAP during the prior week, significant issues (resolved or on-going), samples collected during the prior week for laboratory analysis or archiving, and samples anticipated during the upcoming week for laboratory analysis or archiving.

1.5 Sampling and Analysis Plan Organization

This SAP provides guidance for all field activities by describing in detail the sample and data gathering methods to be used during the Phase 1a field investigation. The organization of this document is as follows:

- Section 2 consists of the Field Sampling Plan (FSP) and presents field methods and procedures
- Section 3 consists of a discussion of parallel activities and project schedule
- Section 4 consists of the Quality Assurance Project Plan (QAPjP) and presents Quality Assurance/Quality Control (QA/QC) procedures

- Section 5 consists of the Data Management Plan (DMP) and presents data management procedures
- Section 6 presents references
- Appendix A consists of the Community Relations Plan
- Appendix B consists of field forms
- Appendix C consists of Standard Operating Procedures
- Appendix D consists of Equipment Operation and Calibration Procedures
- Appendix E consists of Data Validation Checklists and Data Qualifiers

Section 2

Field Sampling Plan

This section presents field procedures that will be used to drill, install and develop three new groundwater monitoring wells at the site, collect soil samples during drilling for lithologic description and laboratory analysis, collect in-situ soil gas samples during drilling (OW1b well location only), collect groundwater samples for laboratory analysis, conduct aquifer testing, and collect field water level measurements during the Phase 1a field program.

The field procedures which will be employed during this investigation are indicated below in the general order of implementation:

- Borehole drilling (including field screening for organic vapors)
- Collection of soil and soil gas samples during drilling
- Well construction and development
- Well elevation surveying
- Water level measurements
- Groundwater sampling
- Aquifer testing
- Site management activities
- Sample management procedures and documentation
- Quality control procedures
- Analytical procedures
- Equipment decontamination
- Investigation Derived Waste (IDW) handling and disposal

Included in Appendix B are the following field forms which may be utilized during the performance of the field activities proposed herein:

- Boring Log
- Monitoring Well Development Log
- Monitoring Well Purge and Sampling Form
- Post-Development Water Level Recovery Log
- Aquifer Pump Test Form
- Chain-of-Custody Record
- Example Sample Label

Sufficient detail has been provided in this section to allow field personnel to conduct the proposed field activities. However, for general guidance and reference purposes, Standard Operating Procedures (SOPs) for applicable field activities have been included in Appendix C. SOPs included in the appendix have been previously reviewed and approved for similar site activities by either EPA Regions VIII or IX, or are modifications of SOPs that have been approved by EPA.

The following SOPs are included in Appendix C and are applicable to this investigation:

- Soil Boring and Rock Coring
- Subsurface Soil Sampling

- Well Installation
- Well Development
- Groundwater Sampling
- Field Logbook
- Duplicate and Split Sample Preparation
- Chain-of-Custody Procedures

Equipment calibration and operating procedures for the following field equipment are included in Appendix D:

- Thermo Environmental 580B Photoionization Detector
- YSI Model 33 Conductivity Meter
- Orion SA250 pH/Eh/Temperature Meter
- LaMotte 2008 Turbidity Meter

2.1 Monitoring Well Drilling and Sampling

Drilling Program Scope of Work

The drilling program scope of work consists of the installation of one on-site (or slightly down-gradient at an adjacent facility) well (OW1b) to 120 feet and two off-site wells (OW2 and OW3) to 90 feet below ground surface (bgs). In order to evaluate whether well OW1b will be step-tested, well OW1b will be installed first, with a water quality sample collected approximately one day after well development is complete. Well OW1b will be installed adjacent to and slightly downgradient of existing on-site well OW1. If access can be obtained, well OW1b will be located at the adjacent Terra-Pave property. If access to the Terra-Pave property cannot be obtained, well OW1b will be located at the subject site. Due to the potential for ponded water in the vicinity (as indicated by water marks on the adjacent buildings), an above-ground completion (i.e., standpipe) will be utilized if well OW1b is installed at the subject site. The two off-site wells will be installed next, with the wells sited on Putnam Street to allow "triangulation" of groundwater elevation data with well OW1. Existing and proposed well locations are illustrated on Figure 2-1. The proposed well locations are approximate and may change depending on access constraints (e.g., overhead power lines, underground utilities, etc.). Proposed completion details for the new wells are illustrated in Figure 2-2.





A general description of drilling techniques is described below, with SOPs (Soil Boring and Rock Coring) included in Appendix C. Well construction details will meet the standard requirements of the Los Angeles County Department of Health Services.

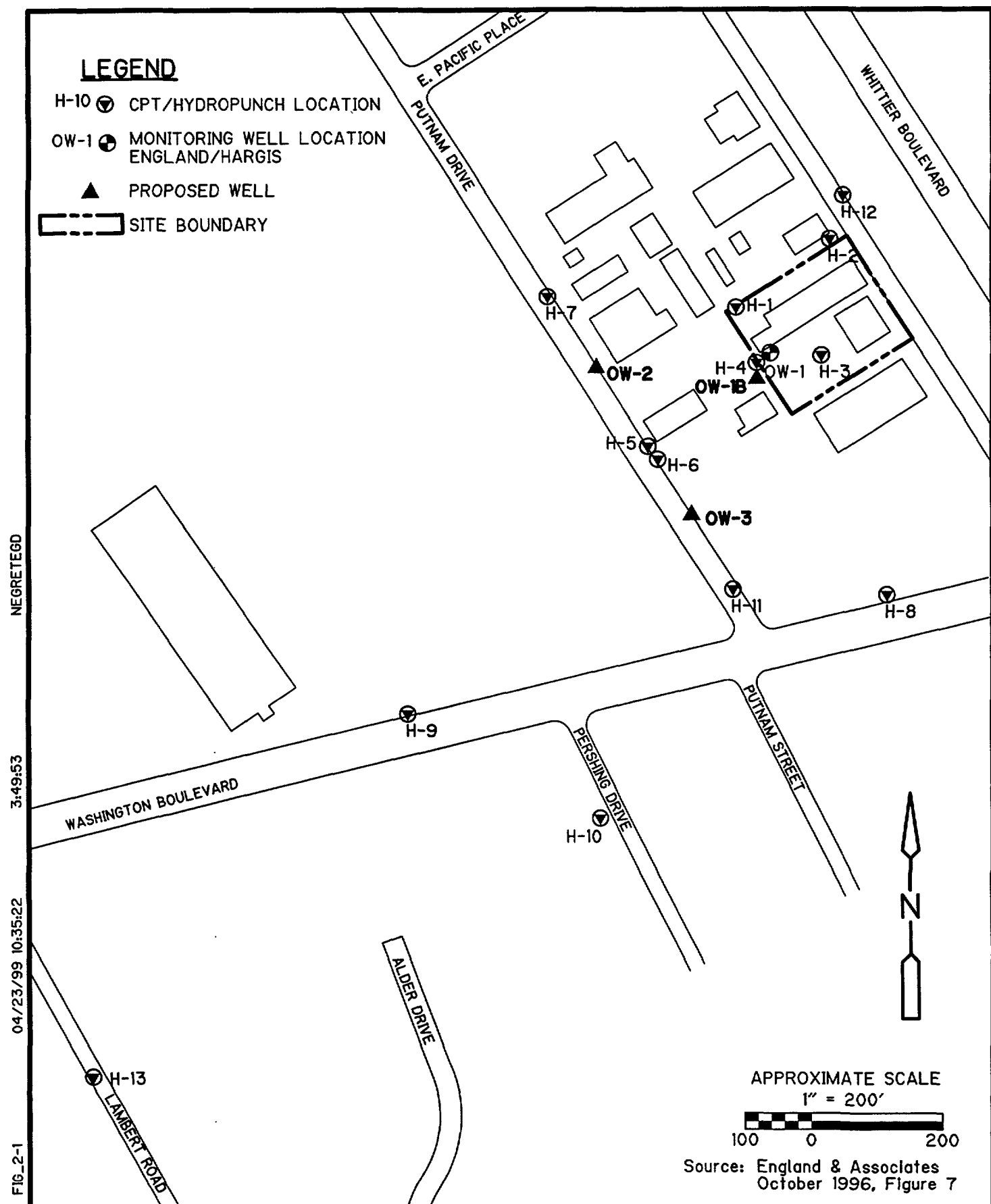
Drill Rig Requirements

The following is a generalized summary of anticipated drill rig requirements and methods:

- A certified drilling contractor with knowledge of the local geologic conditions will be selected. The hollow-stem auger (HSA) rig will be a hydraulically powered drill rig that simultaneously rotates and axially advances the hollow-stem augers. Anticipated drilling depths are relatively shallow (i.e., approximately 90 and 120 feet bgs), therefore, a drilling rig capable of drilling to an approximate maximum depth of 150 feet will be required.

LEGEND

- H-10  CPT/HYDROPUNCH LOCATION
- OW-1  MONITORING WELL LOCATION ENGLAND/HARGIS
-  PROPOSED WELL
-  SITE BOUNDARY



APPROXIMATE SCALE
1" = 200'

100 0 200

Source: England & Associates
October 1996, Figure 7

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PROPOSED MONITORING WELL LOCATIONS

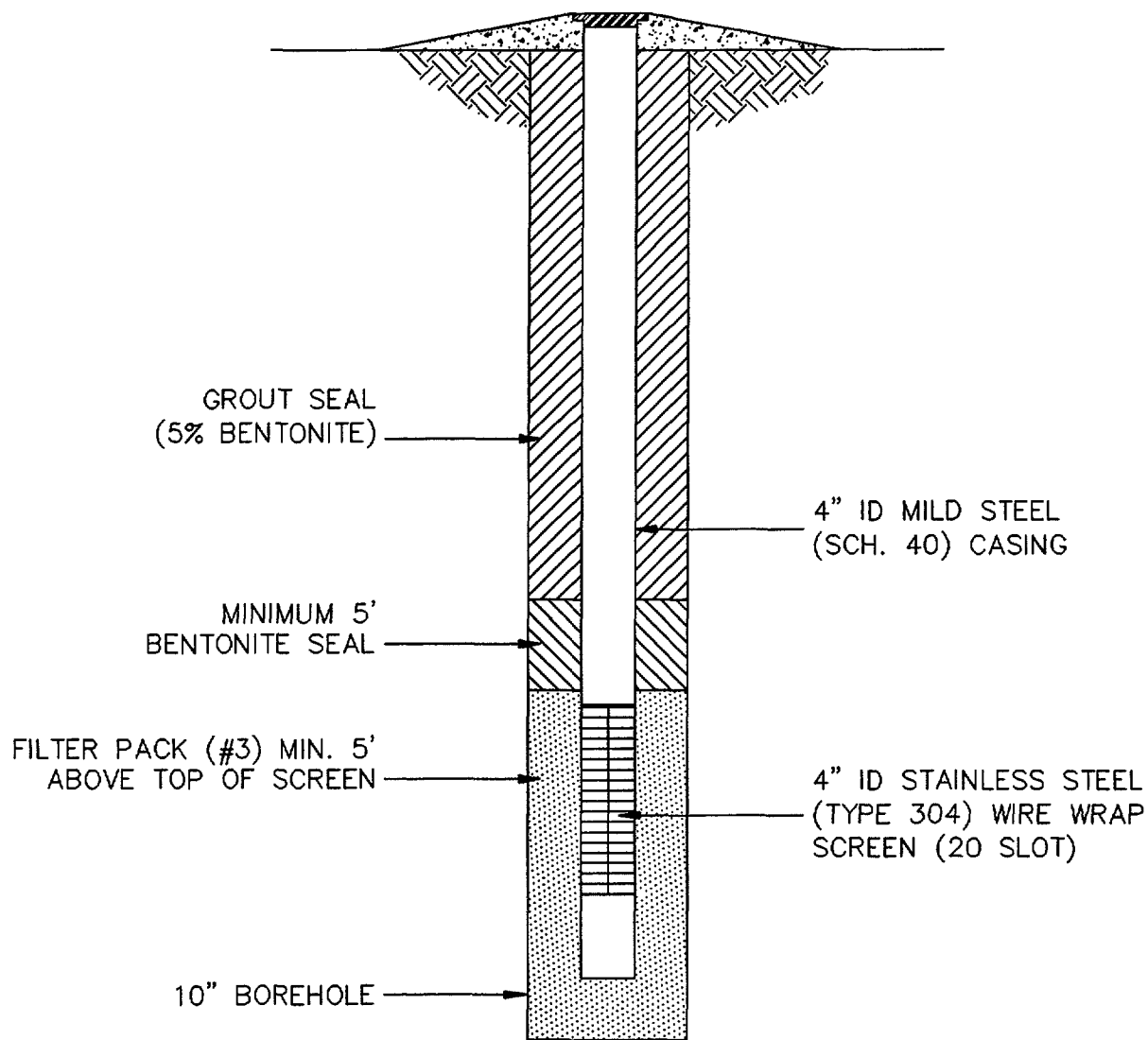
Figure 2-1

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FIG_2-2



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TYPICAL CONSTRUCTION DIAGRAM FOR CONVENTIONAL MONITORING WELL

Figure 2-2

- The rig and augers will be decontaminated prior to first use and after each boring is completed, according to the procedures described in Section 4.6 of this SAP.
- Prior to the initiation of drilling activities at location OW1b, depth to water will be measured in the nearby existing well (OW1) using an electric water level indicator. The depth-to-water measurement will be used to estimate the potential depth to water at location OW1b and may also be useful in determining the depth of the conductor casing at that location.
- Pilot borings will be advanced at all locations, with 8-inch nominal outside-diameter (OD) augers used to advance the pilot borings. In order to minimize the potential for cross contamination, after the pilot boring has been advanced to its total depth, the 8-inch OD augers will be removed and the boring reamed with 10-inch nominal diameter augers prior to installation of the well casing, screen and annular fill materials.

Soil and Soil Gas Sampling Procedures

Soil samples will be collected at all three locations and utilized for lithologic evaluation, with selected soil samples submitted for laboratory analysis of volatile organic compounds (VOCs). Field screening results will be used to assist with selection of soil samples (a total of 12 samples from the pilot boring for well OW1b [approximately every 10 feet] and a total of three from the pilot borings for wells OW2 and OW3 [two from the vadose zone and one from the saturated zone]). When selecting soil samples for laboratory VOC analysis, samples with sustained PID readings will be selected over samples with negative PID readings. Field screening procedures are discussed in greater detail in the following subsection.

The following is a generalized summary of soil sampling procedures:

- A modified California split-spoon sampler will be advanced to the desired depth into the native formation by use of a standard 140-pound hammer with a 30-inch drop. The number of blows required to advance the sampler will be noted on the boring log.
- After advancement, the sampler will be carefully retracted from the augers. In non-cohesive or saturated soils, a sand catcher will be used to help retain the sample.
- The split-spoon sampler will be decontaminated according to the procedures described in Section 4.6 of this SAP.

Representative lithologic samples will be placed in resealable plastic bags which will be labeled with the sample location and depth interval. The Unified Soil Classification System (USCS) will be used to describe sample lithologies, and soil type designations and descriptions. Lithologic descriptions and visual observations will be recorded on the borehole log form found in Appendix B of this SAP.

During drilling of the pilot boring at location OW1b, soil gas samples will be collected from the vadose zone at selected depths using a Simulprobe® sampler (or approved equal). Because soil gas sampling results may be used for future modeling of VOC transport in the vadose zone, these data are intended to meet EPA criteria for definitive data. Sustained PID readings obtained during field screening will be utilized to select depths for soil gas sampling. When selecting soil gas samples for laboratory VOC analysis, samples with sustained PID readings will be selected over samples with

negative PID readings (see discussion below for field screening procedures and selection criteria). The sampler will be advanced (driven) one to two feet below the bottom of the boring into undisturbed soil, and sampling attempted in relatively coarse-grained (e.g., fine to coarse sands and fine gravels) materials. Up to six soil gas sampling attempts will be made, with a maximum of five soil gas samples collected in pre-cleaned and evacuated Summa® canisters provided by the analytical laboratory. In order to ensure that the soil gas samples have not been diluted by the intrusion of atmospheric air, all hoses will be visually observed to verify that they are structurally sound (e.g., no visible holes and cracks) and all fittings will be checked for tightness prior to and immediately after sampling. If a fitting is observed to loosen during sampling, the sample will be discarded and the interval resampled. In addition, all fittings will be compression-type fittings recommended by the manufacturer.

All soil and soil gas samples will be submitted to the laboratory for analysis of VOCs by EPA Methods 8260 and TO-14 (including acetone, Freon 11, Freon 12, and Freon 113 with CLP-like deliverables requested), respectively. The presence of any tentatively identified compounds (TICs) will also be noted on the analytical reports, if detected. Soil matrix VOC results obtained during the Phase 1a investigation will be considered quantitative data even though the Encore® sampler and EPA Extraction Method 5035 will not be utilized. California EPA does not require the use of EPA Extraction Method 5035, therefore, there is only one local laboratory which currently provides this service. Due to past performance concerns, this laboratory was not selected for analysis of the Phase 1a investigation samples. Field preservation using methanol is considered impractical due to the need to handle and weigh soil and hazardous fluids. In addition, field preservation dilutes the sample and increases the reporting limit 50 times. The laboratory will provide both electronic and hard copy reports. A summary of analytical samples is provided in Table 2-1.

Soil samples for archive purposes will also be selected and stored for possible future physical property (e.g., bulk density, porosity, total organic carbon, etc.) testing. Soil-filled stainless steel sleeves selected for archive will be capped and the ends taped. The boring number, sample depth and date collected will be indicated on the sleeve. All archive samples will be placed in a box and stored at CDM's Irvine office.

Field Screening for Organic Vapors and DNAPL

It is anticipated that a Thermo Environmental 580B™ organic vapor meter (OVM, or equivalent PID), equipped with a 10.2 eV photoionization lamp, will be used for field screening purposes. PID field screening results are considered to be qualitative data and will not be used for quantitative purposes. The PID will be calibrated, according to manufacturer's directions, at the beginning of each day using 0 and 100 parts per million (ppm) calibration gases. Generally, 100 ppm isobutylene span gas is used because of the instrument's relatively high sensitivity to it and the non-toxic nature of the gas. The 0 ppm gas will be used for calibration rather than ambient air so that organic vapors from nearby industrial activities do not interfere, or mask, true background measurements. PIDs may be affected by dust and moisture, therefore, care will be exercised to keep the bulb clean and dry. Calibration and operation procedures for the PID are included in Appendix D of this SAP.

Soil samples placed inside the resealable plastic bags will be allowed to sit in the sun (if available) for a short period of time (approximately 5 minutes) to encourage volatility. The volume of cuttings placed in the resealable plastic bag and the length of time the sample is allowed to remain undisturbed prior to screening with the PID will be consistent from sample to sample. The PID

Table 2-1
Sample Collection Summary

		NUMBER OF SAMPLES TO BE COLLECTED			
		Soil Samples		Soil Gas Samples	Groundwater Samples
		Lithologic Description	VOCs (Method 8260)	VOCs (Method TO-14)	VOCs (Method 8260)
Soil, Soil Gas and Groundwater Samples	OW1	--	--	--	1 ^a
	OW1b	24	12	5	1 ^a
	OW2	18	3	0	1
	OW3	18	3	0	1
Quality Control Samples	Duplicate	--	0	1	1 ^b
	Equipment Decontamination Blank	--	2 ^c	--	1
	Laboratory QC (i.e., MS/MSD)	--		--	1

Notes:

- a Wells OW1 and OW1b will be sampled on the same day. Samples will be submitted for 3-day turnaround time.
- b Duplicate groundwater sample will be collected from Well OW1b
- c One blank will be collected from the deep well and one from the first shallow well drilled

probe tip will then be inserted inside each bag and the material screened for organic vapors. In order to minimize loss of volatiles, the plastic bag containing the soil screening sample will be opened only the minimal amount required to insert the tip of the PID. Organic vapors will also be measured inside an empty plastic bag for comparative purposes. PID readings will be considered to be sustained when detections five parts per million greater than background are recorded for a duration of 15 seconds or longer. In the event that PID readings are not sustained or do not exceed background, soil samples for laboratory analysis will be collected at approximate 10-foot intervals. Soil gas samples collected for laboratory analysis from the vadose zone at location OW1b will be collected at approximate 15-foot intervals in the event that PID readings are not sustained or do not exceed background.

Field screening for DNAPL will also be performed during drilling at the location of well OW1b. Soil samples with significant PID detections (e.g., greater than 50 ppm) will be selected for DNAPL field screening. Samples that meet this criteria will be placed in a plastic bag and checked for fluorescence (generally milky white in appearance) using a portable, battery-operated UV light source. The screening will be performed on-site in a darkened area or room. The screening samples will be transported at the end of the drilling program to CDM's Irvine office where they will be checked a second time for fluorescence. A third check will be performed the same day, after the addition of deionized or distilled water to the bagged soil sample (the addition of water has been shown to facilitate the detection of DNAPL). The second and third checks will also be performed in a darkened room, with visual observations noted in the field log book.

Specific details regarding drilling, sampling, and well installation procedures at the newly-installed well locations are provided below. All drilling activities will be performed by experienced field personnel under the supervision of a California Registered Geologist.

2.1.1 Well OW1b Drilling and Installation

A pilot hole will be advanced to approximately 90 feet bgs at the location of well OW1b using HSA methods. Lithologic samples will be collected every five feet using a split-spoon sampler fitted with interior stainless steel sleeves. Soil samples for laboratory VOC analysis will be selected at approximate 10-foot intervals during drilling of the pilot boring (a total of approximately nine samples), in the event that PID readings are not sustained or do not exceed background. As discussed above, when selecting soil samples for laboratory VOC analysis, samples with sustained PID readings will be selected over samples with negative PID readings. As described above, soil samples will also be selected for archiving and possible future physical property testing. In addition, field screening for the presence of DNAPL will also be performed.

Soil gas samples will also be collected from the vadose zone at selected depths using PID field screening results or at approximate 15-foot intervals (as described above) using a Simulprobe® sampler. The sampler will be advanced (driven) one to two feet below the bottom of the boring into undisturbed soil, and sampling attempted in relatively coarse-grained (e.g., fine to coarse sands and fine gravels) materials, if present. Based on the lithologic log for existing on-site well OW1 (see Appendix B), subsurface materials will likely be relatively fine-grained (silts and clays). Due to low permeability, it may not be possible to collect soil gas samples from clay zones. Up to six soil gas sampling attempts will be made, with a maximum of five soil gas samples collected in pre-cleaned and evacuated Summa® canisters provided by the analytical laboratory.

All soil and soil gas samples selected for laboratory analysis will be transported to a fixed-base laboratory at the end of each day's sampling. Soil and soil gas samples will be analyzed for VOCs (including acetone, Freon 11, Freon 12, and Freon 113) by EPA Methods 8260 and TO-14, respectively. The need for any additional soil gas monitoring will be determined at a later date, pending evaluation of the soil gas sampling results and Streamlined Risk Evaluation (SRE) planning. Soil gas concentrations will be factored into the SRE on a quantitative basis.

The pilot boring will be reamed to 20 to 22 inches in diameter using a bucket auger rig. Mild steel conductor casing (12 3/4 inch diameter) will be installed to an approximate depth of 90 feet below ground surface and the annulus grouted with a sand/cement slurry to ground surface. If possible, the casing will be terminated in relatively fine-grained silt and clay materials. A HSA rig will be re-mobilized to the site after allowing a minimum of 24 hours for the cement to cure. A pilot hole will be drilled from 90 to 120 feet, with split-spoon samples collected every 5 feet for lithologic evaluation. Soil samples for laboratory VOC analysis will be selected at approximate 10-foot intervals (a total of approximately 3 samples).

In order to evaluate the vertical extent of groundwater contamination underlying the site, well OW1b is intended to be completed approximately 50 feet below existing well OW1. During drilling of well OW1, subsurface materials consisting of silts and clays were noted to a depth of 80 feet bgs in the boring. Well OW1 was screened in the interval from 62.5 to 77.5 feet bgs. The screen was placed adjacent to clay materials with a thin silt layer noted in the approximate interval from 66 to 67 feet bgs. Depth to water in well OW1 during June 1996 was approximately 68 feet bgs. In the event that a relatively permeable zone (i.e., sand and/or gravel) is encountered at the bottom of the boring, the boring will be advanced an additional 20 feet (maximum 140 feet) or until finer-grained materials (i.e., silts and clays) are encountered. Upon reaching the total depth of the pilot boring (120 to 140 feet), the boring will be reamed to 10 inches in diameter prior to installation of the casing and screen. Mild steel blank casing and stainless steel screen will be utilized due to the potential elevated levels of VOCs which may be encountered. The mild steel blank casing will be 4 inches in diameter, flush threaded, 0.237-inches thick, and approximately 100 feet long. The stainless steel (Type 304) screen will be wire-wrap, 20 slot, 0.237-inches thick, and approximately 10 to 15 feet long.

Annular-fill materials (filter pack, bentonite and grout) will be installed in the annulus using the hollow-stem augers as a temporary tremie pipe. The filter pack will be placed in the annulus from the bottom of the boring to approximately 5 feet above the top of the screen. The interior of the well will then be swabbed to consolidate the filter pack. After swabbing of the well screen, more filter pack will be added if necessary to raise the top of the filter pack to 5 feet above the top of the perforations. Filter pack material will consist of Lone Star No. 3 (8 x 20 gradation) if relatively coarser-grained lithologic materials (e.g., medium to coarse sands and gravels) are encountered adjacent to the screened zone or No. 2/12 (12 x 20 gradation) if relatively finer-grained lithologic materials (e.g., silts and fine sands) are encountered. A bentonite annular seal approximately three feet thick will be placed on top of the filter pack. If bentonite pellets are used, they will be allowed to hydrate approximately 30 minutes before installation of the grout seal. Neat cement with 5% bentonite added will be used to grout the annulus to ground surface.

After installation, the well will be developed by bailing, swabbing, and pumping. A flush-mounted, traffic-rated, tamper and moisture proof well head will be installed after development is complete. If the well is installed adjacent to existing well OW1, an above-grade (i.e., standpipe) well completion will be utilized.

2.1.2 Wells OW2 and OW3 Drilling and Installation

Wells OW2 and OW3 are intended as water table completions and will be screened across the air/groundwater interface. At each location, a pilot hole will be advanced to approximately 90 feet bgs using a HSA rig, with split-spoon samples collected for lithologic evaluation every 5 feet. Three samples per boring (two from the vadose zone and one from the saturated zone) will be selected for laboratory VOC analysis. Several soil samples will also be selected for archiving and possible future physical property testing.

The borings will then be reamed to 10 inches in diameter to approximately 90 feet bgs. Bentonite chips will be installed in any portion of the pilot borings which extend more than three feet below the design depth of the well. The wells will be completed as described above, using approximately 70 feet of mild steel blank casing and 20 feet of stainless steel wire-wrap screen. The screened section will straddle the water table, with 5 feet of screen placed above and 15 feet placed below the air/water interface. After installation, the well will be developed by bailing, swabbing, and pumping. A flush-mounted, traffic-rated, tamper and moisture proof well head will be installed after development is complete.

2.1.3 Soil Cuttings and Fluids Containment

In order to minimize the cost of containment of investigation-derived waste (IDW), soil cuttings will be contained in covered roll-off bins and fluids (decontamination and development water) will be contained in tanks. It has also been assumed that a staging area for the bins and tanks will be provided at the Omega facility.

2.1.4 Wellhead Elevation Survey

All wells installed for, or used as part of, this investigation will be surveyed by a licensed land surveyor using the California Coordinate System (Plane Projection Coordinate of California). Each newly-installed well will be surveyed by a licensed surveyor using California coordinates. X and Y coordinates will be surveyed to the nearest 0.1 feet with Z coordinates surveyed to the nearest 0.01 feet.

2.1.5 Water Level Measurements

Water level measurements will be collected from the existing well OW1 and the three newly-installed wells. Procedures for the collection of water level measurements are provided below.

An electric water level indicator will be used for taking water level measurements. The following is a summary of the methods to be used:

- The probe and line will be decontaminated prior to and after each use following the procedures outlined in Section 4.6 of this SAP.
- Immediately after opening the well cap, with field personnel standing upwind of the wellhead, a PID will be used to monitor the interior of the well for organic vapors. Measurements will be recorded in the field logbook.

- The probe will be lowered slowly into the well until the water surface is indicated. The measurements will be taken from the surveyed measurement point on the well casing.
- A second and third reading will be taken, confirming the initial reading, before the water level indicator is withdrawn from the well.
- Independent measurements of static water levels using the same water level indicator should agree within ± 0.01 foot.
- Measurements will be recorded in the field logbook.

2.1.6 Water Quality Sampling

In order to evaluate whether step-drawdown testing will be performed on well OW1b during the Phase 1a investigation, a water quality sample will be obtained from well OW1b approximately one day after well development is complete instead of the standard three-day equilibration period. Shorter duration equilibration periods are typically used when water quality data are needed as quickly as possible in order to assist with a pending field decision.

Well OW1b and existing on-site well OW1 will be purged using a 2-inch diameter portable submersible pump. When a minimum of three saturated casing volumes of water have been purged from the well and field parameters (electrical conductivity, pH, temperature, and turbidity) have stabilized (see below for stabilization criteria), the pump will be removed from the well. Water level recovery will be measured with a water level indicator. When water levels have recovered to within 90 percent of the static water level measured prior to pumping, a clean, new disposable bailer will be lowered to the middle of the perforated section and used to collect a water quality sample. Well OW1 will also be purged and sampled the same day well OW1b is sampled. Purging and sampling of well OW1 will be performed as described above for well OW1b.

Water quality samples will also be collected from the two newly-installed wells OW2 and OW3 after step-testing activities (including water level recovery) are complete. When a minimum of three saturated casing volumes of water have been purged from each well and field parameters (electrical conductivity, pH, temperature, and turbidity) have stabilized (see below for stabilization criteria), the pump will be turned off and water level recovery measured with a water level indicator. When water levels have recovered to within 90 percent of the static water level measured prior to pumping, the pump will be removed from the well. A clean, new disposable bailer will be lowered to the middle of the perforated section of each well and used to collect a water quality sample. All four groundwater samples (three from the newly-installed wells and one from the existing well) will be submitted to the laboratory for analysis of VOCs (including acetone, Freon 11, Freon 12, and Freon 113) by EPA Method 8260 (CLP-like deliverables requested). The presence of any TICs (if detected) will be noted on the analytical reports. Sampling and analysis for additional analytes (e.g., general minerals) necessary for pre-design evaluation will be performed at a later date. In support of the decision to step-test well OW1b, the samples collected from wells OW1 and OW1b will be submitted for 3-day turnaround time. Samples from wells OW2 and OW3 will be submitted for normal turnaround time (approximately two weeks). The laboratory will provide both electronic and hard copy reports.

Generalized procedures for the collection of water quality samples are provided below:

- A decontamination, sample preparation, and support area will be set up at the wellhead. All equipment and instruments that will be placed into the well casing or will come in contact with water samples will be decontaminated prior to and after use. Equipment decontamination procedures are described in Section 4.6. Instrument calibration and maintenance procedures are provided in Appendix D.
- Depth to water measurements will be taken at the time of sampling. The time of each measurement will be recorded in the field logbook. A decontaminated electric water level indicator will be used to take water level measurements.
- Prior to collecting samples, each well will be pumped until field parameters (i.e., temperature, pH, EC and turbidity) have stabilized and a minimum of three casing volumes have been removed from the well. The stability of field parameters is the best indication that the water being sampled is representative of the groundwater in the aquifer. These water quality measurements will be made at a frequency of 10 percent of the total purge volume (e.g., every 10 gallons for a 100 gallon purge volume). Field parameters will be considered to be stabilized once three consecutive measurements have met the following criteria: when temperature measurements are ± 1 degree Celsius; when pH measurements are ± 0.1 pH unit; and when EC and turbidity measurements are ± 10 percent. The volume of water pumped will also be recorded when measuring field parameters.
- All measurements (field parameters and water levels) will be recorded on the monitoring well purge and sampling form (included in Appendix B), as well as in the field logbook.
- A well casing volume (in gallons) is calculated using the following formula:

$$\pi \times (\text{well radius in feet})^2 \times (\text{head of water [total depth of well minus depth to water]}) \times (7.48 \text{ gallons/feet}^3)$$

- Pre-cleaned VOC containers (40-ml teflon septa glass vials with HCL preservative) will be provided by the laboratory. After filling, the cap will be replaced and the container inverted and tapped sharply against the palm of the sampler's hand to check for bubbles. If bubbles are present, the sample will be discarded and a new sample container will be filled. Samples will immediately be placed in an iced cooler.
- Samples will be labeled and packaged for shipment. Chain-of-custody documentation and any other necessary documentation will be prepared. All samples will be placed in an iced cooler for later delivery or shipment to the laboratory.
- Disposable nitrile gloves will be used during sampling activities. A new pair of gloves will be used at each well.
- Purge water will be containerized in Baker tanks, or equivalent.

2.1.7 Quality Assurance/Quality Control Samples

Several types of Quality Assurance/Quality Control (QA/QC) samples will be collected during the performance of the field program. The type and number of samples is described below and in Section 4.5 of this SAP.

Drilling Program

Two equipment rinsate blanks will be collected from the split-spoon sampler. One sample will be collected during drilling of the pilot boring for well OW1b, with the second sample collected during drilling of the first off-site well. The samples will be collected by pouring distilled water over the decontaminated split-spoon sampler and collecting the rinsate directly into pre-cleaned, preserved VOA vials.

A duplicate soil gas sample will also be collected during soil gas sampling. If possible, the duplicate will be collected at a depth with sustained PID field screening results. Because split-spoon soil samples are co-located samples (collected immediately above or below the sample depth) and are not true duplicates, duplicate soil samples will not be collected.

All QA/QC samples will be submitted to the laboratory for analysis of VOCs by EPA Method 8260 (CLP-like deliverables requested). The laboratory will provide both electronic and hard copy reports. The presence of any TICs (if detected) will be noted on the analytical reports.

Groundwater Sampling

One duplicate groundwater sample will be collected from well OW1b during groundwater sampling, in addition to one equipment blank sample. The equipment blank sample will be collected by pouring distilled water into a pre-cleaned, disposable bailer and collecting the rinsate directly into pre-cleaned, preserved VOA vials. All QA/QC samples will be submitted to the laboratory for analysis of VOCs by EPA Method 8260 (CLP-like deliverables requested).

One laboratory QC sample (triple volume) will also be collected during groundwater sampling. The additional sample containers will be labeled "for matrix spike/matrix spike duplicate (MS/MSD) analysis" and will be used by the laboratory for their internal quality control. Samples for laboratory QC will be selected from locations where low levels of contamination are expected (as determined by field screening methods or historical data). Selection of QC samples with low, rather than moderate to high, levels of contamination will minimize the potential of diluting out the spike concentration. Laboratory QC samples will be designated on the chain-of-custody record. The laboratory will provide both electronic and hard copy reports for all QA/QC samples.

2.2 Aquifer Testing

The purpose of aquifer testing is to assist with the design of the groundwater containment/remediation system (treatment plant and extraction wells) currently proposed for the site. Due to the anticipated elevated VOC levels of the pumped groundwater, short term step-drawdown testing is proposed instead of long term constant rate testing to minimize the volume of water requiring disposal. If evaluation of the step-drawdown testing results indicates that longer term pumping is necessary to design the remediation system, then additional testing will be proposed during subsequent phases of the site investigation.

The proposed off-site well locations were selected in order to evaluate aquifer parameters at potential extraction well locations. Due to the low permeability subsurface materials underlying the site, the radius of influence during pumping is likely to be in the 10s of feet and not 100s of feet range. Wells at adjacent properties (e.g., former Chevron site), therefore, are located too far laterally to be of use for monitoring during the proposed aquifer testing.

Aquifer parameters such as well efficiency, transmissivity, hydraulic conductivity and vertical leakance (and possibly storativity and anisotropy) will be estimated using the test results. At the present time, it is not possible to state which methodologies (e.g., Theis, Neuman, etc.) will be used to evaluate the aquifer test data. An appropriate method will be selected after review of the field data. The results of the evaluation will be used to design the proposed containment/remediation system.

Step-drawdown testing will be performed on each newly-installed off-site well after development activities are complete. At the location of well OW1b, step-testing may be performed pending a comparison of the water quality results from well OW1b and existing well OW1.

It is estimated that each well will be pumped at four steps, with each pumping step lasting approximately one hour. During development, the maximum pumping rate of each well will be estimated. This maximum rate will be divided by four to determine the approximate rate of each step. For example, if the well is capable of a maximum pumping rate of 10 gallons per minute (gpm), the four steps will be 2.5, 5, 7.5 and 10 gpm. During pumping, the discharge rate will be checked periodically (e.g., every 10 to 15 minutes) using a calibrated bucket and stop-watch. After each pumping step, the well will be allowed to recover for approximately one hour before the next pumping step is started. Recovery will be considered to be complete when the water level has recovered to within 95% of its pre-test level. Evaluation of the step-test results will provide information on well loss, specific capacity, and transmissivity in the vicinity of the tested wells. Pumped groundwater will be temporarily contained on site pending evaluation of pre-disposal sampling results.

Wells OW2 and OW3 Step-Testing

After development activities are complete at the locations of wells OW2 and OW3, the wells will be allowed to recover overnight, with step testing performed the next day (if the wells are capable of sustaining a minimum pumping rate of 10 gallons per minute [gpm]). A pre-test is not required because the correct operation of the pump and maximum pumping rate will have been determined during development. During step-testing, a transducer will be installed in each pumping well and used to monitor changes in water level. In order to minimize the likelihood of equipment or operator error, the data logger will be set to record at 10 second intervals throughout the test. This interval will yield a sufficient quantity of measurements to properly evaluate the results. Manual measurements will also be collected on a typical logarithmic progression (e.g., every minute for the first ten minutes, every 2 minutes from 10 to 20 minutes, every 5 minutes from 20 to 30 minutes, and every 10 minutes from 30 to 60 minutes into each step) using a water level meter.

Well OW1b Step-Testing

At the location of well OW1b, due to concerns regarding the potential for the downward vertical migration of VOCs observed in the shallow zone in the vicinity of well OW1, step-testing will only be performed if deemed appropriate after evaluation of the water quality results from well OW1b

and existing well OW1. If elevated levels of VOCs are found in both wells, well OW1b will be step-tested as described above for wells OW2 and OW3. If the concentrations detected in well OW1b are an order of magnitude (or greater) less than well OW1, then well OW1b will not be step-tested. Water levels will be collected from both newly-installed well OW1b and existing well OW1 as described above, using data loggers and water level meters.

If step-testing is performed at location OW1b, the proper operation of the pump and transducers will be tested prior to starting the test. Static water level will also be measured prior to installation of the pump. Water levels will be measured after checking the operation of the pump and allowed to recover to pre-test static conditions before initiating step-testing.

2.3 Field Sampling and Monitoring Equipment

Where available, procedures for maintenance, calibration, and operation are included in Appendix D of this SAP. All maintenance and calibration operations will be documented in the field logbook. Where standard procedures for pieces of equipment are not available, all maintenance, calibration, and operating procedures will be performed as recommended by the manufacturer. Copies of those instructions will be available to the field personnel during the investigation, as appropriate.

Prior to use, all field equipment will be checked and calibrated to verify that it is in good working order. The calibration, maintenance, and operating procedures for all instruments are based upon manufacturer's instructions and common industry practice.

2.4 Site Management Activities

This section addresses the activities associated with site management during implementation of the proposed field program. The project manager will be responsible for general project supervision to ensure that field and laboratory activities meet project objectives. The field manager will be responsible for obtaining site access and coordination with property owners. In addition, the field manager will be responsible for overseeing all field activities. Site management activities include site access and site security.

2.4.1 Site Access

It will be the field manager's responsibility to assure that site access has been obtained prior to entry to the site by the project team members or subcontractor personnel. OPOG is working with City of Whittier staff to obtain access for installation, testing, and sampling of the two off-site wells (OW2 and OW3). Draft permit requirements and access agreements are currently being reviewed by OPOG and City staff. In correspondence dated January 25, 1999, EPA formally requested access to the adjacent Terra Pave property for the installation, testing, and sampling of well OW1b. As of the date of this submittal, Terra Pave staff had not responded to EPA's request. Final locations for the proposed wells will be determined during the site access process. Field investigation activities may require access to potable water and electrical power. The project team or subcontractor personnel will utilize these on-site services only with the permission of the property owner.

2.4.2 Site Security

Drilling and sampling locations may be on unsecured public or private property. Appropriate measures will be taken to assure that the individual sites are secured against unauthorized entry. In

addition, any special provisions contained in the access agreements with the individual property owners will be implemented. Site security at individual drilling or pumping test locations will be the responsibility of the drilling subcontractor.

A staging area will be made available at the site for the centralized storage of materials and equipment, and temporary storage of investigation-derived waste.

2.5 Sample Management Procedures and Documentation

The following sections discuss various sample management procedures that will be followed during the performance of the proposed field activities. Included in this section are procedures for sample collection, sample identification, sample containers and preservation, sample labeling, chain-of-custody documentation, sample packaging and transportation, and field logbooks.

2.5.1 Sample Collection

Soil, soil gas, and groundwater samples will be collected during the proposed field program. General soil and soil gas collection procedures were discussed in Section 2.1.1 of this SAP, with groundwater sample collection procedures discussed in Section 2.1.6.

2.5.2 Sample Identification

A coding system will be used to identify each sample collected during this investigation. The coding system will allow tracking and retrieval of information concerning a particular sample, and will assure that each sample is uniquely identified. Each sample will be identified by site number, sample media type, location type or station, and date. The site identification for all samples collected during this investigation will be OC, representing the Omega Chemical site. Codes for sample media type designations will be as follows:

- GW = Groundwater samples
- S = Soil samples
- SG = Soil Gas samples

Quality control (QC) codes will be appended to the well number, where appropriate. The following QC codes will be used:

- N = Decontamination Rinsate Blank (equipment blank)
- K = Split (groundwater and soil gas duplicate samples)

Typical sample numbers will be as shown below:

<u>Site Number</u>	<u>Sample Media</u>	<u>Well No./Depth (ft)</u>	<u>Date</u>
OC-	GW-	OW3-	030199
OC-	SG-	OW1b-60	051599

For example, a sample identification number of OC-SG-OW1b-60-051599 would indicate a soil gas sample collected from the location of well OW1b at a depth of 60 feet bgs on May 15, 1999. The

laboratory will not be informed of the sample identification code, therefore, they will not know which samples are quality control samples.

2.5.3 Sample Containers and Sample Preservation

Sample preservation, holding time, container, and volume requirements for groundwater samples have been summarized in Section 4.4.1 of this SAP. Containers for groundwater sample collection will be procured through the analytical laboratory and will not be rinsed before sampling.

2.5.4 Chain-of-Custody Records

The purpose of chain-of-custody procedures is to document the identity of the sample, and its handling, from its first existence as a sample until information derived from it is introduced as evidence during legal proceedings. Custody records trace a sample from its collection through all transfers of custody until it is transferred to the analytical laboratory.

Custody records will be used for the samples collected during the proposed field program. The multi-part carbonless copy forms will be correlated with the sample collection labels; requested information will have the same heading on both. The sampler or sample custodian will complete a Chain-of-Custody Record to accompany each sample shipment from the field to the laboratory. An example Chain-of-Custody Record is presented in Appendix B.

The following information will be supplied on the Chain-of-Custody Record:

- Project code number
- Signature of sampler
- Sample identification
- Sample matrix
- Date and time of sample collection
- Signatures of all persons receiving or relinquishing the samples
- Sample analyses required for each sample
- Preservative used will be noted
- Number of sample containers will be noted

2.5.5 Sample Labels

Each collected sample, including duplicates and decontamination rinsate blanks, will have a completely filled-in sample label securely attached to it. The label will be completely filled-in prior to filling the sample containers. All field QA samples will be shipped "blind" to the laboratory, but will be assigned a unique identification code (see Section 2.5.2 of this SAP) to facilitate identification of the laboratory results. Labels will include the project code number, the location of the sampling site, the type of sample and analysis required, the preservative used, and the time of sampling. A blank example label is included in Appendix B.

2.5.6 Sample Packing and Shipment

All filled sample containers will be placed in resealable plastic bags and into iced coolers. All glass containers will be enveloped with plastic bubble-wrap. Ice packs will be placed in the sample coolers to comply with preservation requirements. Ice packs will consist of either blue ice placed

inside a plastic bag or double bagged ice cubes. A Chain-of-Custody Record, as well as other appropriate documentation, will be placed in resealable plastic bags and into the sample coolers. All samples will be transported by CDM personnel or laboratory courier, in private or company owned vehicles, to local laboratories.

2.5.7 Field Logbook

Field logbooks will be used to record and document all data collection activities at the site. All measurements and samples collected will be recorded. Any deviations from the SAP will also be noted. Entries will be as descriptive as possible, so that a particular situation can be reconstructed without reliance on the collector's memory. Entries will be made in pen; no erasures will be permitted. If an incorrect entry is made, the data will be crossed out with a single line and initialed.

Field logbooks will be bound and, preferably, contain water resistant paper with consecutively numbered pages. Logbooks will be permanently assigned to field personnel and will be stored in CDM's files when not in use. Indicated on the cover of each logbook will be the person or organization to whom the book is assigned, book number, project name and code number, start date, and end date. At the beginning of each sampling day, the following information will be recorded: date, start time, weather, field personnel present, level of personal protection being used on site, and the signature of the person making the entry. In addition, instrument calibration information (including instrument serial numbers) will be recorded each day. If the same instruments are used for each sampling event, the serial numbers only need to be recorded at the beginning of the sampling event. The date and signature of the person recording entries will be written on every page.

At each station where a sample is collected or a measurement is made, a detailed description of the location of the station will be noted. Equipment used to collect samples will also be recorded in the logbook, along with the time of sampling, sample description, volume and number of samples, and the date on which the equipment was calibrated. Sample numbers will also be recorded. Split samples, which receive a separate sample number, are also noted. Significant field logbook entries (samples collected, significant observations, etc.) will be reviewed and countersigned by another member of the project team at the end of each sampling day or major sampling activity.

2.6 Containment and Disposal of Investigation-Derived Waste

Investigation-derived waste (IDW) generated during field activities generally includes: drill cuttings; well development, purging, and aquifer testing water; decontamination fluids; and used personal protective equipment (PPE), debris (e.g., empty cement bags, casing wrapping materials, etc.), and miscellaneous disposable sampling equipment. IDW is expected to be classified as nonhazardous. It is anticipated that these materials will be handled as described in the following sections. All hazardous substances will be disposed at an off-site facility in accordance with EPA's Off-Site Rule.

2.6.1 Drill Cuttings

All soil cuttings generated from drilling activities will be placed in lined and covered roll-off containers or 55-gallon drums and temporarily stored on-site. Cuttings contained in 55-gallon drums will be kept to a minimum, due to the increased cost of characterizing and disposing of the material contained in the drums. Cuttings which appear to contain VOCs (based on positive field

screening results) will be segregated from those which appear to be free of VOCs. Two composite soil samples for pre-disposal analysis will be collected from each bin that appears to contain VOCs, with one composite sample collected from each bin which appears to be free of VOCs. It is anticipated that soil cuttings from the vadose zone at off-site well locations OW2 and OW3 may be free of VOCs and may be contained in one roll-off bin. Soil cuttings from below the water table at all three well locations, in addition to the vadose zone at location OW1b, may contain VOCs and may be contained in a separate roll-off bin. If additional analyses (e.g., semi-volatiles, metals, pesticides, etc.) or samples are required by a disposal facility, additional samples will be collected as required.

After the completion of the 8021 analyses, for those soil samples which exceed detection levels, calculations will be made to determine the probable maximum TCLP concentration. The probable maximum contamination levels will be based on the worst case assumption that all contaminants in the soils will dissolve. The calculation will be to divide the soil concentrations by the appropriate TCLP liquid/water ratio (20:1) to determine maximum potential aqueous concentration. TCLP analyses would be performed on only those samples whose calculated maximum concentrations exceed the TCLP limits defined in 40 CFR 261.24. The list of analytes for EPA Method 8021 was compared to the TCLP analyte list. The only compounds present on the TCLP list and not included in the EPA Method 8021 analysis are hexachlorobenzene, methoxychlor and methyl ethyl ketone. These analytes are not compounds of concern at the site, therefore, this is not considered to be problematic.

It is difficult to estimate the number of samples which will be collected because the volume of soil generated is dependent on site-specific lithologic conditions. Practical experience has shown that subsurface materials which consist primarily of fine-grained deposits usually generate a larger volume of cuttings. Subsurface materials which consist of coarse-grained deposits generally generate a smaller volume of IDW. Final determination of the number of samples will be made subsequent to completion of drilling activities, once the total volume of drill cuttings is known.

If the cuttings are determined to be hazardous, they will be transported (accompanied by hazardous waste manifests) to approved disposal facilities for treatment and/or disposal. The appropriate signatures will be obtained from the Respondents and wastes will be disposed in accordance with federal and state regulations. If determined nonhazardous, they will be transported to approved locations, such as a Class III landfill for soils.

2.6.2 Well Development, Purging, Aquifer Testing and Decontamination Fluids

Decontamination fluids generated during drilling activities will be containerized in 55-gallon drums, Baker tanks, or equivalent. Baker tanks will also be used for temporary containment of aquifer testing water. Practical experience has shown that one composite sample collected from each container and submitted for VOC analyses is adequate to characterize the waste. If additional analyses (e.g., semi-volatiles, metals, pesticides, etc.) or samples are required by the disposal facility, additional samples will be collected as required. It is difficult to estimate the number of samples which will be collected because the volume of fluids generated is very dependent on site-specific lithologic conditions. Final determination of the number of samples will be made subsequent to completion of field activities, once final volumes can be determined.

It is anticipated that water from well development, purging, sampling, and decontamination activities will be treated with granular-activated carbon (or an equivalent treatment alternative pre-approved by EPA), if necessary, to reduce VOC concentrations and meet LARWQCB requirements prior to discharge to a local storm drain or flood control channel. The treatment system will be designed based on an evaluation of the waste characterization sampling results. Used granular activated carbon (GAC) will be regenerated or disposed in accordance with federal and state regulations. In the event that discharge of treated water to a local storm drain is proposed, the LARWQCB and Los Angeles County Department of Public Works will be notified of the intended discharge. Discharge to the storm drain system is generally allowed by the LARWQCB if the treated water contains VOCs at concentrations less than MCLs and is non-turbid. Los Angeles County Industrial Wastewater Discharge Permit (No. 8513) for the Omega facility permitted a one-time low flow discharge. This permit is no longer valid, therefore, discharge of treated groundwater to the sewer system under Permit No. 8513 is not a disposal alternative.

In the event that post-treatment VOC concentrations are in excess of regulatory discharge requirements, the liquids will be transported and disposed of at a regulatory approved facility. If the liquids are determined to be hazardous, hazardous waste manifests for their disposal will be prepared, and the wastes will be disposed in accordance with federal and state regulations.

2.6.3 Personal Protective Equipment, Debris and Miscellaneous Sampling Equipment

Used gloves, tyveks, respirator cartridges, disposable filters, and other miscellaneous items will be double-bagged using plastic trash bags and then disposed as solid waste. Items such as empty cement bags, wrapping materials, and used plastic sheeting will be placed directly into solid waste dumpsters. Items that appear to be contaminated with hazardous materials or wastes will be inserted into plastic bags and placed inside 55-gallon drums for subsequent disposal at an appropriate disposal facility. The drums will be inventoried and labeled to indicate the origin (borehole or well number) of the drum contents.

2.6.4 Labeling Requirements

All drums, roll-off containers and Baker tanks will be labeled with a pre-printed, unclassified materials label. The label states that the unclassified materials are being temporarily held pending evaluation of laboratory analyses. The label also notes the site name, date, type of materials stored, and origin of materials stored.

2.7 Field Activity Schedule

It is anticipated that the Phase 1a field activities will take approximately 1 month to complete. As previously discussed, well OW1b will be installed and sampled first, followed by installation and sampling of off-site wells OW2 and OW3. A schedule for Phase 1a activities is provided in Section 3 of this document.

2.8 Phase 1a Field Investigation Report Organization and Contents

It is anticipated that the Phase 1a field investigation report will contain the following sections and general content:

- Section I, Introduction - purpose, background, and scope of work
- Section 2, Physical Characteristics of the Area - location, physiology, climate, geology, and hydrogeology
- Section 3, Phase 1a Investigation Field Activities - field procedures (e.g., well drilling and installation; soil, soil gas, and groundwater sampling; aquifer testing.), and deviations from the SAP
- Section 4, Data Presentation and Evaluation - soil, soil gas, and groundwater sampling results; direction of groundwater flow and hydraulic gradient results, aquifer testing results
- Section 5, Conclusions and Recommendations - summary of findings, identification of additional data needs (if required), recommendations for additional work
- Section 6, References

The report organization and contents may be modified based on evaluation of the field procedures and sampling results. As discussed in Section 3 of this document, ARARs development and preparation of SRE planning documents will be performed concurrent with the Phase 1a investigation and will be provided to EPA as separate submittals.

Section 3

Parallel Activities and Schedule

As described below, additional activities SRE (Streamlined Risk Evaluation) Planning and ARARs (Applicable or Relevant and Appropriate Requirements) development will be performed concurrent with the Phase 1a field investigation.

3.1 Streamlined Risk Evaluation Planning

Planning for the SRE will be performed concurrently with the field investigations. The planning task will include initial risk assessment tasks necessary to support quantitative risk estimates:

- Evaluation of data quality and data quality objectives to complete the SRE within CalEPA and USEPA guidance
- Identification of Chemicals of Potential Concern (COPC)
- Development of a Site Conceptual Exposure Model (SCEM)
- Exposure pathways analysis based on the SCEM
- Development of a list of draft Removal Action Objectives (RAOs) for potential vadose zone and groundwater zone response actions.

The SRE is intended to focus risk assessment efforts on media and response actions to be addressed in Phase 1 of risk management for the Omega Chemicals site. Phase 1a addresses groundwater containment downgradient of the site, and the presence of vapors of COPCs in the vadose zone. A containment remedy for near-site groundwater presupposes that contaminated groundwater will not be used for drinking or other purposes that would involve significant human contact. However, a containment remedy does not automatically consider other exposure pathways which may be identified during Phase 1b, such as migration of vapors from the vadose zone to indoor air, or potential exposure during deep excavation and construction. The SRE will concentrate on such pathways for both Phases 1a and 1b that may be complete within the zone of groundwater containment.

Key factors for SRE planning will include:

- Development of data quality objectives that include consideration of detection limits, sample numbers, data representativeness and needs for vapor transport modeling
- Evaluation of options for vapor transport modeling, including consideration of models based on transport from soils, groundwater or soil gas.

- Identification of additional data that may have to be collected to support the SRE, especially the vapor transport modeling
- Evaluation of possible exposure pathways, with special attention on approaches to evaluation of pathways involving vapor transport from the vadose zone
- Development of RAOs which can address exposure pathways and potential risks identified in the SCEM

Completion of SRE planning will require evaluation and use of data to be collected during the field investigation. Thus, though some of the planning process can be completed along with the field investigation, other parts of the analysis will have to wait until additional information from the field has been gathered. For this reason, SRE planning will be carried out concurrently with the field investigation.

The SRE planning document will be prepared in draft form for review and comment. Revision of the SRE is not anticipated. Instead, comments on the SRE planning document will be incorporated into the SRE when completed. As shown on the project schedule (Figure 3-1), the SRE planning document will be submitted to EPA approximately one week after submittal of the draft Phase 1a Field Investigation Report. As shown on the schedule, submittal of the SRE planning document will be concurrent with ARARs submittal and is anticipated on August 19, 1999.

3.2 ARARs Development

Concurrent with preparation of the Phase 1a investigation planning documents and performance of the Phase 1a field program, the process of identifying ARARs will begin. The ARARs identification process will continue during implementation of the Phase 1a investigation activities and during subsequent investigation phases and conclude with preparation of EE/CA (Engineering Evaluation/Cost Analysis) and/or feasibility study documents. ARARs development will be performed in consideration of appropriate preliminary remediation goals and Remedial Action Objectives (RAOs) for the Omega site. RAOs are the formal statement of overall objectives and goals for the site and consist of media-specific goals for protecting human health and the environment.

Based on review of historical site information, the contaminants of interest at the Omega site are VOCs. The primary medium of interest appears to be regional groundwater, however soils and air ARARs will also be evaluated. Accordingly, the priority groundwater ARARs will be developed immediately. This will assist with the development of ARARs for other media, which will be developed in the next phase of work, concurrent with any necessary on-site soil investigation and completion of the SRE. The associated primary exposure pathways are public water supply systems in the vicinity of the site. The preliminary remediation goals would therefore be Federal or California MCLs, whichever are more stringent, for the contaminants of interest emanating from and associated with the Omega site, measured at the point of potential exposure.

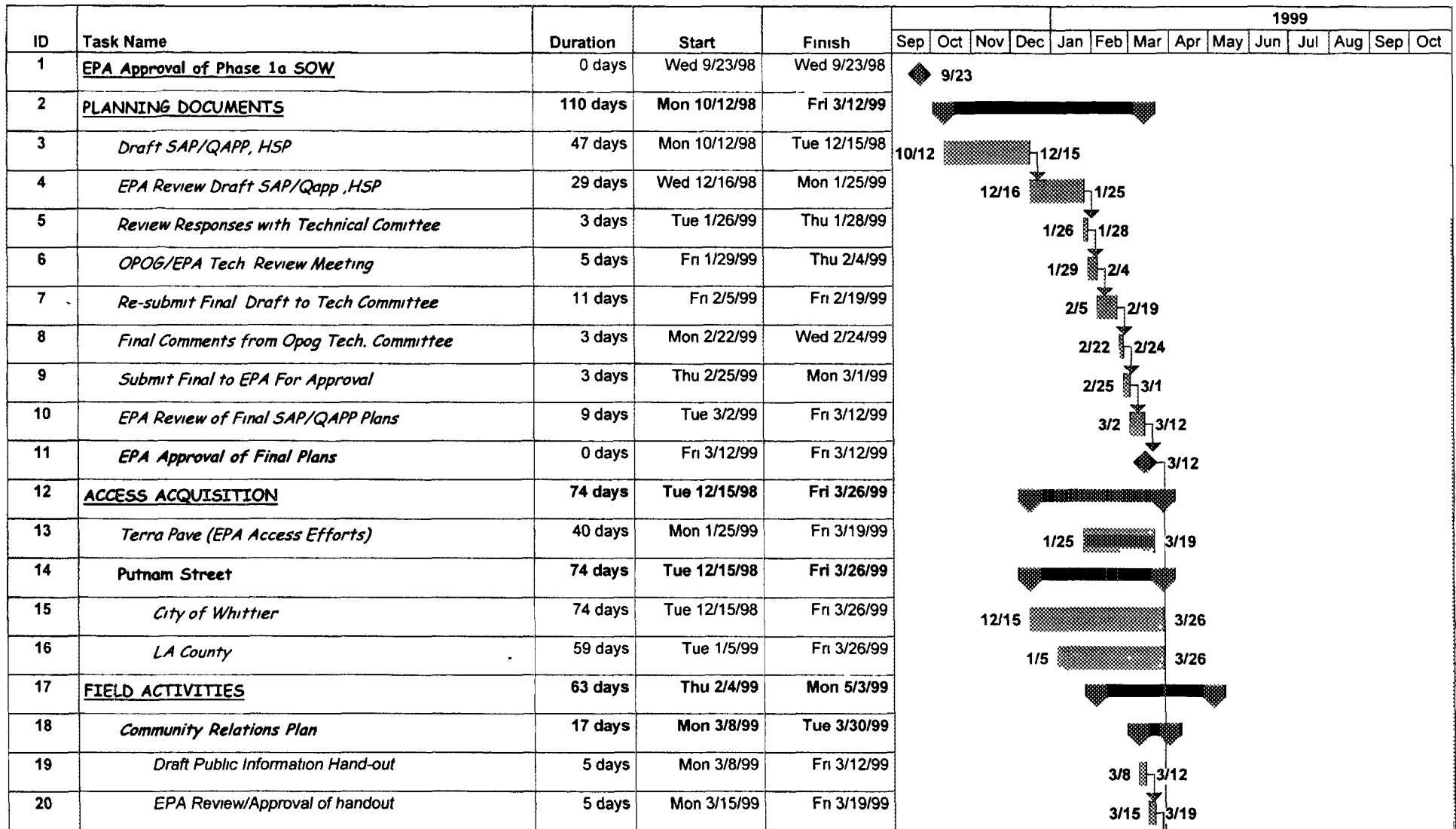
Based on the preceding information, the following initial RAOs may be appropriate:

- The remedy will protect drinking water sources such as Santa Fe Springs well 30R3 from contaminants associated with and emanating from the Omega site.
- The remedy will provide containment of VOC concentrations which are (a) indicative of NAPL and/or (b) located near stratigraphic conditions reflecting a transition to higher hydraulic conductivities.

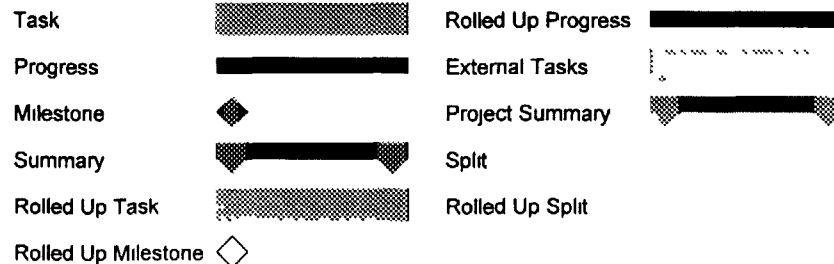
These RAOs may be modified and additional RAOs and associated ARARs may be developed during the performance of the Phase 1a investigation and subsequent investigations. As shown on the project schedule (Figure 3-1), a preliminary identification of ARARs will be submitted to EPA approximately two weeks after submittal of the draft Phase 1a Field Investigation Report. ARARs submittal will be concurrent with submittal of the SRE planning document. Other media-specific ARARs would be developed at a later date, as described above.

3.3 Overall Phase 1a Investigation Schedule

Phase 1a investigation activities will be performed as indicated in the attached schedule (Figure 3-1). It is anticipated that the draft investigation summary report will be submitted to EPA for review approximately 12 weeks after the final analytical reports have been received from the laboratory.














DRAFT
OMEGA CHEMICAL SITE
 Phase 1a Field Investigation Project Schedule
 Thu 3/4/99



ID	Task Name	Duration	Start	Finish	1999											
					Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
41	EPA Review	21 days	Thu 8/19/99	Thu 9/16/99												8/19
42	OPOG Technical Committee Responses	5 days	Fri 9/17/99	Thu 9/23/99												9/17
43	EPA Review of Final Report	14 days	Fri 9/24/99	Wed 10/13/99												9/24
44	EPA Approval	1 day	Thu 10/14/99	Thu 10/14/99												10/14
45	ARARs DEVELOPMENT	184 days	Mon 2/1/99	Thu 10/14/99												
46	OPOG Technical Committee Review Draft Report	143 days	Mon 2/1/99	Wed 8/18/99												
47	EPA Review	21 days	Thu 8/19/99	Thu 9/16/99												8/19
48	OPOG Technical Committee Responses	5 days	Fri 9/17/99	Thu 9/23/99												9/17
49	EPA Review of Final	14 days	Fri 9/24/99	Wed 10/13/99												9/24
50	EPA Approval	1 day	Thu 10/14/99	Thu 10/14/99												10/14

NOTE: A revised schedule will be submitted to EPA as soon as access for proposed monitoring well locations has been approved.

DRAFT OMEGA CHEMICAL SITE Phase 1a Field Investigation Project Schedule Thu 3/4/99	Task		Rolled Up Progress	
	Progress		External Tasks	
	Milestone		Project Summary	
	Summary		Split	
	Rolled Up Task		Rolled Up Split	
	Rolled Up Milestone			

Section 4

Quality Assurance Project Plan

This Quality Assurance Project Plan (QAPjP) describes the minimum QA/QC requirements for sampling activities during the Phase 1a field investigation. The purpose of this QAPjP is to provide a foundation for collection of data that meet the data quality objectives (DQOs) established for the Phase 1a field investigation. DQOs are qualitative and quantitative statements specified to ensure that data of known and appropriate quality in support of remedial response activities and decisions are generated. Data generated during the Phase 1a field investigation will support engineering judgements in order to construct, maintain and monitor the water treatment system.

Quality assurance is defined as the integrated program designed for assuring reliability of monitoring and measurement of data. Quality control is defined as the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measuring process. Quality assurance procedures such as tracking, reviewing, and auditing are implemented as necessary to ensure that all project work is performed in accordance with professional standards, regulations and guidelines, and specific project goals and requirements.

This QAPjP addresses the requirements set forth in EPA's regulations and guidance documents (40 CFR 300) and includes procedures designed to ensure the precision, accuracy, completeness, comparability and representativeness of new data generated during the course of the Phase 1a field investigation. Further, this QAPjP provides the quality assurance requirement for data handling and manipulation during all phases of this project. It is intended to guide field, laboratory, engineering, and management personnel in all relevant aspects of data collection, management, and control while on or off site.

4.1 Project Objective and Scope

The primary objective and scope of work for this project are discussed in detail in Sections 1 and 2 of this document, respectively. In general, data generated during the Phase 1a field investigation will be used to support engineering judgements in order to assess groundwater quality at and immediately downgradient of the Omega Chemical Superfund site and, in parallel, begin the process of identifying ARARs and evaluating the nature and extent of any risks posed by known or suspected contamination. With respect to the groundwater investigation, three new groundwater monitoring wells will be installed at the site: one on-site (or slightly downgradient at an adjacent facility) well (OW1b) will be installed to an approximate depth of 120 feet bgs and two off-site wells (OW2 and OW3) will be installed to approximate depths of 90 feet bgs. The proposed work is intended to (a) provide additional data regarding the vertical distribution of contaminants directly beneath the site, (b) collect sufficient piezometric and hydraulic data to better define the groundwater flow direction and potential rate of flow, and (c) establish permanent monitoring points that may be used during design and operation of an appropriate remedy to address the near-site contamination.

Although the scope of work is focussed primarily on investigating groundwater quality, limited soil and soil gas data will also be collected during the Phase 1a field program. Soil gas samples will be collected from selected depths within the vadose zone while drilling each of the boreholes. Data collected from the soil gas samples may be used in evaluating potential risks to human health and

the environment and possible contaminant transport pathways. Soil samples will be collected at approximate 5-foot intervals from each borehole and will be used primarily for lithologic evaluation. Selected soil samples will be submitted for laboratory VOC analysis. Soil data will also be used to evaluate vertical trends in contaminant distribution and to evaluate potential contaminant transport pathways.

4.2 Project Team Organization and Responsibilities

This section presents the project team organization and team member responsibilities. The work will be performed by staff from the CDM offices located at the addresses shown below:

Camp Dresser & McKee Inc.
18881 Von Karman, Suite 650
Irvine, CA 92612
Phone: 949/752-5452
Fax: 949/752-1307

Camp Dresser & McKee Inc.
1331 17th Street, Suite 1200
Denver, CO 80202
Phone: 303/298-1311
Fax: 303/298-8236

Project coordination is provided by the firm indicated below:

de maximis, inc.
5225 Canyon Crest Drive
Building 200/Suite 253
Riverside, CA 92507
Phone: 909/222-0387
Fax: 909/222-0389

The Phase 1a Field Investigation Report (draft and final) will be distributed to the following agencies and individuals:

Mr. Craig Cooper
United States Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105
Phone: 415/744-2370
Fax: 415/744-2180

Mr. Shawn Haddad
California Department of Toxic Substances Control
1011 North Grandview Ave.
Glendale, CA 91201
Phone: 818/551-2962
Fax: 818/551-2850

4.2.1 Key Personnel

Key personnel and their roles are indicated in Figure 4-1 (Project Team Organizational Chart). The Project Coordinator is Chuck McLaughlin. The key CDM team members are David C. Chamberlin, S.V.P. (Project Manager), Sharon L. Wallin, R.G. (Principal Investigator), Richard Wilson, P.E. (Project Engineer), Brigitte Howe (Risk Assessor), and Barbara Wells (Quality Assurance Manager). Technical review will be performed by the Technical Review Committee consisting of Suzanne M. Rowe, R.G.; Joseph Bellas, P.E.; and Jim Lavelle, Ph.D. Additional technical review will be provided by the OPOG Technical Committee.

4.2.2 Special Training and Certification Requirements

During the field phase portion of this investigation, all work will be performed under the supervision of a California Registered Geologist. All CDM personnel working onsite will hold current certification showing that they have received training in accordance with requirements specified in 29 CFR 1910.120 (Occupational Safety and Health [OSHA]) regulations. Documentation and records verifying this training will be maintained by CDM's Health and Safety officer.

It is anticipated that Del Mar Analytical (Del Mar), located in Irvine California, will be selected as the project analytical laboratory. Del Mar is certified through California Department of Health Services' Environmental Laboratory Accreditation Program (ELAP). Any subcontracted laboratory will also be required to be certified by ELAP.

4.2.3 Project Schedule

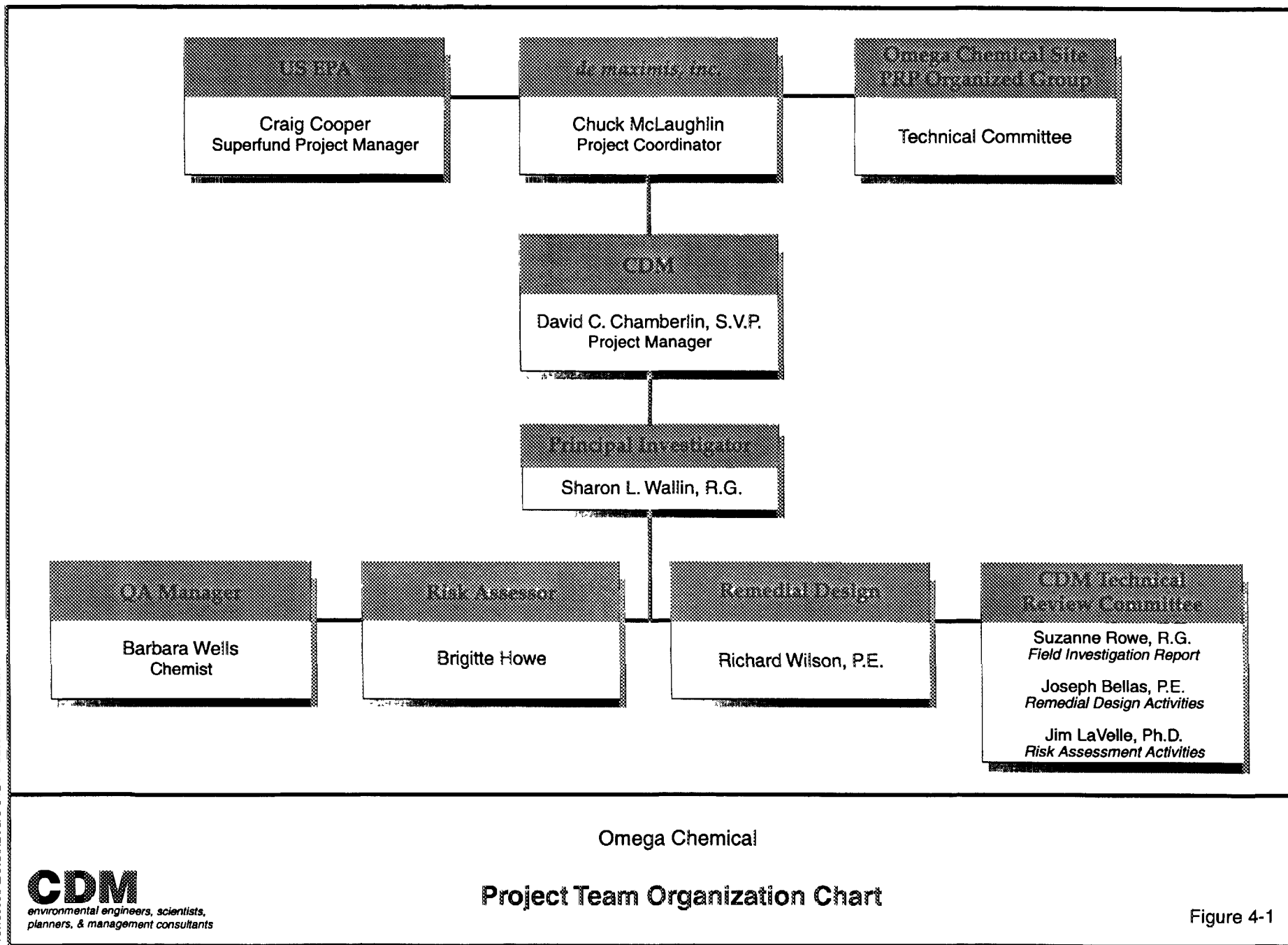
The overall project schedule and key deliverable due dates for the Phase 1a investigation activities are shown on Figure 3-1, located at the end of Section 3 of this document. It is anticipated that the draft investigation summary report will be submitted to EPA for review approximately 12 weeks after the final analytical reports have been received from the laboratory.

4.3 Quality Assurance Objectives for Measurement Data

The overall quality assurance objective for sampling data is to ensure that the data generated are of documented quality for the intended data uses. To achieve these objectives, data will be: 1) representative of actual site physical and chemical conditions; 2) comparable to other studies, where appropriate; 3) complete to the extent that necessary conclusions may be reached; and 4) of known quantitative statistical significance in terms of precision and accuracy, at levels appropriate for each stated data use for the project.

4.3.1 PARCC Parameters

Data quality is assessed in terms of precision, accuracy, representativeness, completeness, and comparability (also known as the PARCC parameters). Descriptions of these characteristics are provided in the following paragraphs.



Precision

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation around the mean or relative percent difference (RPD) between two samples. The RPD between duplicate sample results is calculated using the following equation:

$$RPD = (D_1 - D_2) / [(D_1 + D_2) / 2] \times 100$$

where:

RPD = Relative Percent Difference

D₁ = First sample value

D₂ = Second sample value (duplicate)

Precision of reported results is a function of sample homogeneity, inherent field-related variability, shipping variability, and laboratory analytical variability. Various measures of precision exist depending upon "prescribed similar conditions." Field duplicate (i.e., split) samples will provide a measure of the contribution to overall variability of field-related and to some extent laboratory-related sources.

Contribution of laboratory-related sources to overall variability is also measured through various laboratory QC samples (laboratory duplicates, etc.).

Accuracy

Accuracy is the degree of conformity of a measurement (or an average of measurements of the same parameter), X, with an expected reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, (X/T) 100 (equal to percent recovery).

Accuracy is a measure of the bias in a system. Performance evaluation standards (blind standards) will be submitted to the laboratory at a target frequency of once every six months. Analytical performance on these reference samples will provide a measure of the analytical accuracy of the laboratory. Internal laboratory QC samples (matrix spikes and standards) will also yield accuracy information.

Representativeness

Representativeness is the degree to which data accurately and precisely represent the true value of a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition, intended to be characterized.

Representativeness of reported results depends upon a number of considerations including, but not limited to, proper monitoring design, selection of appropriate field methodology, proper sample preparation, preservation and handling, selection and execution of appropriate analytical methodology, and proper sample identification and reporting of results.

Data will be obtained during the Phase 1a field activities according to the sampling methodology developed and discussed in Section 2 (FSP) of this document. The documentation requirements will establish that the protocols have been followed and sample identification and integrity assured.

Equipment blanks and duplicates will be used to assess field and transport sample contamination and method variation.

Completeness

Completeness is a measure of the amount of valid data expressed as a percentage obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. For this project, the completeness parameter will be assessed through the data validation procedures discussed in Section 4.7.

Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability may be assessed by comparing sampling methodology, analytical methodology, and units of reported data. The comparability requirements for field measurement and sampling activities will be maintained by following protocols and SOPs specified in this document. Data comparability will be ensured by use of consistent methods and consistent units. Environmental samples collected during the project activities will be analyzed using EPA-defined procedures referenced in this document.

4.3.2 Data Quality Objectives

DQOs are qualitative and quantitative statements specified to ensure that data of known and appropriate quality in support of remedial response activities and decisions are generated. The process of developing DQOs for projects involving environmental data collection activities is not intended to be an independent requirement, but is meant to be integrated into the normal process of planning, designing and carrying out such projects. DQOs should be jointly developed by both the data users and the data collectors.

The DQO development process consists of determining what information is needed; why it is needed; how it will be used and who will use it; evaluating different monitoring approaches based on cost and resource constraints; selecting the most cost-effective monitoring approach that will meet the needs of the ultimate data user; and formulating data quality objectives. Results of the DQO development process translated into specific sampling and laboratory methodology requirements. DQOs will facilitate data collection activities, and will yield data meeting the needs of the user.

4.3.2.1 Data Categories

Field and analytical data can be used for a vast number of purposes ranging from qualitative field screening data to quantifiable enforcement level data. EPA has developed two descriptive data categories to assist in the interpretation of data: 1) screening data with definitive confirmation, and 2) definitive data. Screening data are generated by rapid, less precise analytical or sample preparation methods and provide analyte identification and quantification, however, quantification may be somewhat approximate. Definitive data, on the other hand, are generated using rigorous analytical methods, generally EPA-approved reference methods, with confirmation of analyte identity and concentration. Definitive data generate tangible raw data and require additional QA/QC elements, including, but not limited to, QC blanks, matrix spike samples, and performance evaluation (PE) samples.

For this program, all groundwater, soil and soil gas samples submitted for laboratory analyses will be analyzed according to definitive data requirements (EPA 1993). All samples will be analyzed using standard EPA approved methods at an off-site analytical laboratory. Table 4-1 provides a listing of the data deliverable requirements that will be provided by the laboratory.

4.3.2.2 DQOs by Activity

The DQO stages have been and will be undertaken in an interactive and iterative manner whereby all the elements of the DQO process are continually reviewed and applied during execution of the project and will be revised or expanded as needed based upon the results of each data collection activity. The following data collection activities are anticipated:

- Groundwater monitoring well drilling, and soil and soil gas sampling
- Groundwater monitoring well sampling and laboratory analysis
- Water level measurements
- Aquifer testing

Sampling objectives are discussed in Section 2.1 of this document. Precision and accuracy control limits established to achieve the project DQOs for laboratory quality control samples analyzed with the project samples are included in Section 4.6.

The following sections summarize the DQOs for the anticipated field activities.

Groundwater Monitoring Well Drilling

A total of three groundwater monitoring wells will be installed as part of the Phase 1a field investigation. To achieve the objectives of the well drilling program and to attain data of known quality, SOPs for borehole drilling and well development will be followed. The PID used for field screening will be calibrated, operated and maintained according to manufacturer's recommended procedures. The PID will be capable of detecting total organic vapors at concentrations ranging from 1 to 2,000 ppm.

Soil Sampling

Soil samples will be collected at approximate 5-foot intervals from each of the three boreholes. To achieve the objectives of the soil sampling program, methods described in Section 2 of this document will be followed. Data generated during soil sampling will be used primarily for lithologic description. To ensure data of known and consistent quality, the USCS will be used to describe sample lithologies, and soil type designations and descriptions. Lithologic descriptions will be presented on standard boring logs (example included in Appendix B). Select soil samples will also be submitted to the analytical laboratory for analysis of VOCs using EPA Method 8260. These soil samples will be used to evaluate general trends in the vertical distribution of contaminants. The objectives of the soil sample analytical program will be achieved when the samples are analyzed in accordance with EPA Method 8260 and when the laboratory reports the analytes at limits shown on Table 4-2. Laboratory QC requirements are detailed in Tables 4-3 and 4-4. Select samples will also be archived for possible additional physical property testing during subsequent phases of the investigation.

Soil Gas Sampling

Soil gas samples will be collected from selected depths within the vadose zone while drilling at location OW1b. Data collected from the soil gas samples may be used in evaluating potential risks to human health and the environment and possible contaminant transport pathways. To achieve the objectives of the soil gas sampling program, sampling methods described in Section 2 of this document will be followed. In addition, the objectives will be achieved when the samples are analyzed in accordance with EPA Method TO-14 and when the laboratory reports the analytes at limits shown on Table 4-2. A summary of the minimum laboratory QC requirements is specified in Table 4-3.

Groundwater Monitoring Well Water Quality Sampling and Analysis

To achieve the objectives of the water quality sampling and analysis program and to attain data of known quality, methods described in Section 2 of this document will be followed. Specific data quality objectives for each of the analytical parameters are determined by consideration of specific uses/decisions, users, and regulatory requirements. In general, the DQOs of the water quality sampling program will be achieved when the laboratory reports the analytical parameters at the limits shown on Table 4-2, and analyzes the samples in accordance with EPA Method 8260. The laboratory selected for chemical analyses will conform to QC requirements set forth in the methods specified in this document.

Aquifer Testing

It is anticipated that aquifer testing will be performed at the three newly-installed monitor well sites. Details specific to the aquifer testing program are presented in Section 2.2. The objectives for this activity will be accomplished by following methods specified in Section 2.2.

Water Level Measurements

Water level measurements will be collected during well development, aquifer testing, and groundwater monitoring activities.

During aquifer testing, drawdown and recovery data for the pumping well will be collected by an automated data logger. Additionally, an electric water level indicator will be used to periodically confirm data logger measurements and to check water levels before and after the aquifer tests. Water levels measured during well development and piezometer monitoring activities will be performed using an electric water level indicator.

Water level monitoring data collected from the monitoring wells will be used to construct groundwater elevation maps, which will be used to evaluate the direction and gradient of groundwater flow underlying the site.

The objectives for water level activities will be achieved by conforming to SOPs and by following manufacturer's instructions in the operation of the data logger, pressure transducers, and electric water level indicator. Accuracy and precision tolerances of water level measurements collected with the electric water level indicator will be within ± 0.01 foot. Accuracy and precision limits of the measurements obtained using the data logger will be specified by the manufacturer, and dependent upon the type of pressure transducer and data logger used.

Table 4-1
Laboratory Data Deliverable Requirements

A list of the minimum information that should be included in a laboratory analysis data report is provided below. Reporting requirements include a sample report, quality control results, and instrument performance results.

Each analytical set (20 or fewer samples) will be compiled into a data package that contains the following elements:

1. Case Narrative which includes an explanation of difficulties encountered, potential effect on the data and/or corrective action taken.
2. Chain-of-custody documentation (location, date and time of sample collection)
3. An analysis results page for each sample which contains:
 - Unique Report Identifier
 - Laboratory Name, Address and Phone Number
 - Client Name
 - Project Name
 - Client Sample Identifier
 - Laboratory Sample Number
 - Date Sample was Collected
 - Date Laboratory Received the Sample
 - Analysis Method Number
 - Date of Extraction/Digestion (if applicable)
 - Extraction/Digestion Method Number
 - Date of Successful Analysis
 - Dilution Factor
 - Concentration Units
 - Reporting Limit for Each Analyte
 - Concentration of Each Target Analyte in the Sample
 - Data Qualifiers (when applicable)
 - Percent Recovery of Each Surrogate Compound Spiked into the Sample (where applicable)
4. QC Results
 - Blank Results (method, initial and continuing calibration), including documentation of detection limits
 - Laboratory Control Sample and QC Check Sample Results (including analyte, known and found concentrations, percent recovery and acceptance criteria)
 - Spike Results (blank spikes, matrix spikes,), including spiked amount, unspiked and spiked sample concentrations, percent recovery and acceptance limits
 - Duplicate Results (sample duplicates and matrix spike duplicates), including sample ID, analyte, original and duplicate sample concentrations, relative percent difference and acceptance limits
 - Control charts for any QC limits determined by laboratory
5. Additional Supporting Documentation
 - Instrument Tuning Results (MS analyses)
 - Initial Calibration Statistics Report
 - Continuing Calibration Statistics Report
 - Internal Standard Results
 - Standard and Sample Preparation Logs
6. Electronic Deliverables
7. Laboratory Raw Data from Instruments and Bench Records

Table 4-2
Target Compound List and Reporting Limits
Volatile Organic Compounds

	EPA Method 8260				EPA Method TO-14
	Groundwater Samples		Soil Samples		Soil Gas Samples
Analyte	Reporting Limit ($\mu\text{g/L}$) ¹	MCL ($\mu\text{g/L}$) ²	Reporting Limit (mg/Kg)	PRG (mg/Kg) ³	Reporting Limit (ppb (v/v))
Acetone	10	--	0.010	1,444	10
Benzene	0.50	1	0.002	0.62	2.0
Bromobenzene	1.0	--	0.005	28.1	NT
Bromochloromethane	1.0	--	0.005	--	NT
Bromodichloromethane	1.0	100#	0.002	0.98	2.0
Bromoform	1.0	100#	0.005	56.2	2.0
Bromomethane	1.0	--	0.005	3.84	2.0
n-Butylbenzene	1.0	--	0.005	134	NT
sec-Butylbenzene	0.50	--	0.005	105	NT
tert-Butylbenzene	1.0	--	0.005	122	NT
Carbon tetrachloride	0.50	0.5	0.005	0.23	2.0
Chlorobenzene	1.0	70	0.002	53.8	2.0
Chloroethane	1.0	--	0.005	1,600	4.0
Chloroform	1.0	100#	0.002	0.24	2.0
Chloromethane	1.0	--	0.005	1.21	4.0
2-Chlorotoluene	1.0	--	0.005	152	NT
4-Chlorotoluene	1.0	--	0.005	--	NT
Dibromochloromethane	1.0	100#	0.002	5.28	2.0
1,2-Dibromo-3-chloropropane	5.0	0.2	0.005	0.32	NT
1,2-Dibromoethane	1.0	0.05	0.002	0.0049	2.0
Dibromomethane	1.0	--	0.002	545	NT
1,2-Dichlorobenzene	0.50	600 (b)	0.002	370	2.0
1,3-Dichlorobenzene	1.0	--	0.002	40.6	NT
1,4-Dichlorobenzene	1.0	5	0.002	3.03	2.0
Dichlorodifluoromethane (Freon 12)	5.0	1,000 (a)	0.005	93.6	2.0
1,1-Dichloroethane	0.50	5	0.002	571	2.0
1,2-Dichloroethane	0.50	0.5	0.002	0.34	2.0
1,1-Dichloroethene	0.50	6	0.005	0.052	2.0
cis-1,2-Dichloroethene	0.50	6	0.002	41.9	2.0
trans-1,2-Dichloroethene	0.50	10	0.002	62.1	2.0
1,2-Dichloropropane	1.0	5	0.002	0.34	2.0
1,3-Dichloropropane	1.0	--	0.002	--	NT
2,2-Dichloropropane	0.50	--	0.002	--	NT
1,1-Dichloropropene	1.0	--	0.002	--	NT
cis-1,3-Dichloropropene	0.50	0.5	0.002	0.081	2.0
trans-1,3-Dichloropropene	0.50	0.5	0.002	0.081	2.0
Ethylbenzene	1.0	700	0.002	230	2.0

Table 4-2
Target Compound List and Reporting Limits
Volatile Organic Compounds

	EPA Method 8260		EPA Method TO-14		
	Groundwater Samples		Soil Samples		Soil Gas Samples
Analyte	Reporting Limit (µg/L) ¹	MCL (µg/L) ²	Reporting Limit (mg/Kg)	PRG (mg/Kg) ³	Reporting Limit (ppb (v/v))
Hexachlorobutadiene	1.0	--	0.005	5.69	4.0
Isopropylbenzene	1.0	--	0.002	156	NT
p-Isopropyltoluene	1.0	--	0.002	--	NT
Methylene chloride	10	5	0.020	8.49	2.0
Methyl tert-butyl ether	10	35 (a)	0.005	--	NT
Naphthalene	1.0	--	0.005	54.8	NT
n-Propylbenzene	1.0	--	0.002	134	NT
Styrene	1.0	100	0.002	1,700	2.0
1,1,1,2-Tetrachloroethane	1.0	--	0.005	2.85	NT
1,1,2,2-Tetrachloroethane	1.0	1	0.002	0.36	2.0
Tetrachloroethene	0.50	5	0.002	4.72	2.0
Toluene	0.50	150	0.002	520	2.0
1,2,3-Trichlorobenzene	1.0	--	0.005	--	NT
1,2,4-Trichlorobenzene	1.0	70	0.005	475	20
1,1,1-Trichloroethane	0.50	200	0.002	685	2.0
1,1,2-Trichloroethane	0.50	5	0.002	0.815	2.0
Trichloroethene	0.50	5	0.002	2.71	2.0
Trichlorofluoromethane (Freon 11)	0.50	150	0.005	383	2.0
1,2,3-Trichloropropane	1.0	--	0.010	0.0014	NT
Trichlorotrifluoroethane (Freon 113)	5.0	1,200	0.005	5,600	2.0
1,2,4-Trimethylbenzene	1.0	--	0.002	51.3	2.0
1,3,5-Trimethylbenzene	1.0	--	0.002	21.2	2.0
Vinyl chloride	0.50	0.5	0.005	0.021	2.0
o-Xylene	1.0	1,750 (b)	0.002	210	2.0
m,p-Xylenes	1.0	1,750 (b)	0.002	280	2.0

Notes:

- ¹ Reporting Limits (RLs) shown are for samples that have not been diluted. RLs are matrix dependent and may be higher or lower than listed.
- ² California Primary Maximum Contaminant Level (MCL)
- ³ EPA Region IX Preliminary Remediation Goals (PRGs) for residential soils
- # Total Trihalomethanes
- (a) California Action Level
- (b) Single isomer or sum of isomers
- No standard
- NT Not a target analyte

Table 4-3
Summary of Minimum Laboratory
Quality Control Requirements
Organic Analyses

EPA Method		8260	TO-14
Sample Matrix		Water/Soil	Soil Gas
Analytical Method Type		GC/MS	GC/MS
MS Tuning Requirement	Frequency	12 hours	Daily
	Standard	4-Bromofluorobenzene	4-Bromofluorobenzene
Initial Calibration	No. Stds.	5	3 + Blank
	Max. %RSD	Calibration Check Compounds (CCCs) <30% All other target analytes: <15%	<30%
Continuing Calibration	Frequency	12 hours	Daily
	Max. %D	CCC \pm 20%	--
	IS Area	-50 to +100% of last continuing calibration Min. Relative response factor (RRF) of 0.10 to 0.30 for the five System Performance Check Compounds (SPCC) (refer to method)	--
Method Blank	Frequency	12 hours	Daily
	Criteria	<MDL	<0.2 ppbv
LCS	Frequency	1/20 samples	1/20 samples
	Criteria	Refer to Table 4-4 for control limits	Refer to Table 4-4 for control limits
Matrix Spike	Frequency	1/20 samples	--
	Criteria	Refer to Table 4-4 for control limits	--
Duplicates	Type	MS Dup	LCS Dup
	Frequency	1/20 samples	1/20 samples
	Criteria	RPD<20%	RPD<20%
Quality Control Standard	Frequency	Quarterly	Audit sample
	Criteria	By QCS Source	90 - 110%
Surrogates	Name (control limits)	Toluene-d8 (water 88-110%, soil 81-117%) 4-Bromofluorobenzene (water 86-115%, soil 74-121%) Dibromofluoromethane (water 86-118%, soil 80-120%) 1,2-DCA-d4 (water 80-120%, soil 80-120%)	Toluene-d8 (70-130%) 4-Bromofluorobenzene (70-130%) 1,2-DCA-d4 (70-130%)
Internal Standards	Name	Fluorobenzene 1,4-Dichlorobenzene-d4 Chlorobenzene-d5	Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5

Notes:

-- = Not applicable to, or not required by, the analytical method. If not required by the specific method, the laboratory may perform additional QC as part of an internal quality control program.

Laboratory must perform corrective action for any method-required QC element that is not within criteria specified in this table or the analytical method, in accordance with individual methods, and as directed in the laboratory's internal standard operating procedures.

Table 4-4
Acceptance Limits for Spiked Samples
Organic Analyses

Spiked Sample Type		LCS	MS/MSD			
Sample Matrix		--	Water		Soil	
		Recovery (%)	Recovery (%)	RPD (%)	Recovery (%)	RPD (%)
EPA Method 8260	Benzene *	65 - 130	65 - 140	20	60 - 140	25
	Chlorobenzene *	75 - 125	75 - 130	20	70 - 135	20
	Chloroform	65 - 135	60 - 150	20	65 - 140	20
	1,1-Dichloroethane	60 - 140	55 - 160	20	55 - 150	20
	1,2-Dichloroethane	55 - 135	40 - 160	20	55 - 145	30
	1,1-Dichloroethene *	55 - 145	45 - 165	50	45 - 165	40
	Ethylbenzene	70 - 125	70 - 135	20	70 - 140	20
	MTBE	60 - 140	60 - 150	25	55 - 155	40
	Tetrachloroethene	65 - 130	50 - 155	20	10 - 200	50
	Toluene *	70 - 125	70 - 135	20	65 - 140	20
	Trichloroethene *	70 - 130	65 - 130	20	60 - 145	30
	Vinyl chloride	40 - 145	25 - 190	20	30 - 160	30
	m,p-Xylenes	70 - 130	65 - 140	20	40 - 160	20
	o-Xylene	70 - 135	70 - 150	25	65 - 150	20
EPA Method TO-14	Methylene chloride	80 - 120				
	1,2-Dichloroethane	70 - 120				
	1,1-Dichloroethene	80 - 120				
	Toluene	70 - 120				
	1,1,2,2-Tetrachloroethane	60 - 130				

Notes:

* = Method-specified spiking compound

-- = Not applicable to, or not required by, the analytical method. If not required by the specific method, the laboratory may perform additional QC as part of an internal quality control program.

Acceptance limits for EPA Method 8260 provided by Del Mar Analytical

4.4 Sampling Procedures

The objectives of sampling procedures and field measurements are to obtain samples and measurements that accurately and precisely represent the environment being monitored. Trace levels of contaminants from external sources must be eliminated through the use of proper sampling techniques, proper sampling equipment, proper decontamination procedures, and experienced/trained field personnel.

Field measurements and sampling will be performed in accordance with accepted procedures. Sampling objectives and procedures for this project are included in Sections 2.1 through 2.6.

4.5 Sample Custody and Documentation

4.5.1 Chain-of-Custody

Sample identification records and chain-of-custody records will be used. The National Enforcement Investigations Center (NEIC) Policies and Procedures Manual provides chain-of-custody and document control procedures. The remainder of this section discusses the chain-of-custody and document control requirements specified in the above document that are appropriate to this project. These procedures will be followed. If any deviations occur, appropriate personnel will be notified and deviations will be noted in the field logbooks.

4.5.1.1 Definition of Custody

A sample is under custody if one or more of the following criteria are met:

- The sample is in the custodian's (sampler, lab personnel, etc.) possession
- It is in the custodian's view after being in possession
- It was in the custodian's possession and was locked up to prevent tampering
- It is in a designated secure area

4.5.1.2 Field Custody Requirements

Chain-of-custody for samples collected in the field and transported or shipped to laboratories for analysis will be maintained. CDM field personnel will have overall responsibility for sample custody and for field document control during the field investigation. The field on-site coordinator will ensure that the samplers have the appropriate identification and custody records, will resolve custody problems in the field, and will handle the shipment of samples to the analytical laboratories.

4.5.1.3 Transfer of Custody and Shipment

Chain-of-Custody Record Sheets

Custody records will be used for the samples collected during this project. The multi-part carbonless copy forms will be correlated with the sample collection labels; requested information will have the same heading on both. Laboratory QC samples will be indicated on the chain-of-custody record sheet. The sampler will complete a chain-of-custody record to accompany each sample shipment from the field to the laboratory. The person who physically collects the sample is the sampler and will complete the chain-of-custody. An example chain-of-custody record sheet is included in Appendix B.

The custody records will be used for a packaged lot of samples; more than one sample will usually be recorded on one form. More than one custody record sheet may be used for one package, if necessary. The purpose of the custody record is to document the transfer of a group of samples traveling together; when the group of samples changes, a new custody record is initiated. The original custody record travels with the samples; the initiator of the record keeps a copy. When custody of the same group of samples changes hands several times, some people will not have a copy of the custody record. This is acceptable as long as the original custody record shows that each person who had received custody has properly relinquished custody. General use instructions follow:

Using a Multi-Part Custody Record Sheet

- The originator fills in all requested information from the sample labels
- The originator signs in the top left "Relinquished by" box and keeps the copy
- The original record sheet travels with the samples
- The person receiving custody checks the sample label information against the custody record. He also checks sample condition and notes anything unusual under "Comments" on the custody form
- The person receiving custody signs in the adjacent "Received by" box and keeps the original
- The date/time will be the same for both signatures since custody must be transferred to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures
- When samples are shipped via common carrier, the original travels with the samples and the shipper (e.g., CDM field personnel) keeps the copy. The shipper also keeps all shipping papers, bills of lading, etc.
- In all cases, it must be readily seen that the same person receiving custody has relinquished it to the next custodian

Questions/Problems Concerning Custody Records

If a discrepancy between sample label numbers and custody record listings is found, the person receiving custody should document this and properly store the samples. The samples should not be analyzed until the problem is resolved by contacting a responsible authority (i.e., CDM's quality assurance coordinator).

The person receiving custody should attempt to resolve the problem by checking all available information (other markings on sample container, type of sample, etc.). He should then document the situation on the custody record and in his field logbook and notify the appropriate responsible authority in order to resolve the problem as soon as possible.

Changes may be written in the "Comments" section of the Custody record and should be initialed and dated. A copy of this record should accompany the written notification to the sample

custodian. A complete copy of the documentation of the problem and its resolution should also be provided to the Project Manager and included with the project files.

4.5.1.4 Laboratory Custody Procedures

Custody procedures that will be followed by the analytical laboratory are outlined below:

- Upon receipt at the laboratory, each sample shipment will be inspected to assess the condition of the shipping container and the individual samples, and the condition or integrity of the custody seals on a received shipment of samples will be documented at the time of receipt by the laboratory. Any problems identified by this process will also be documented and the sample custodian will be notified by the fastest available means, followed by written notification.
- Enclosed chain-of-custody records will be cross-referenced with all the samples in the shipment; these records will be signed by the sample custodian and placed in the project file.
- The laboratory sample custodian will continue the chain-of-custody process by assigning a unique laboratory number to each sample on receipt; this number identifies the sample through all further handling.
- Internal log books and records that maintain the chain-of-custody throughout sample preparation and analysis.

4.5.2 Sample Labels

Each sample and field QC sample, including duplicates or decontamination rinsate blanks, will have a sample label completely filled-in and securely attached to it. All field QC samples will be shipped "blind" (i.e., the sample is not identified as a QC sample) to the laboratory, and will be assigned a unique identification code in order to facilitate identification of the laboratory results.

4.5.3 Sample Shipment

All samples collected during the field activities, and shipped for laboratory analysis, will be labeled, packed and shipped in accordance with DOT regulations, which include documentation requirements. Sample containers will be placed in a sample cooler. Sample containers will be placed in resealable plastic bags with packing material (i.e., vermiculite, etc.) designed to prevent breakage during shipment. Ice packs will be placed in the sample coolers to comply with preservation requirements. A chain-of-custody record, as well as other appropriate documentation, will also be placed in resealable plastic bags and then into the sample coolers. All samples requiring transport to the laboratory will be shipped as environmental samples by common carrier or hand delivered to local laboratories within 24 hours from the time of sample collection (or sooner for analyses with shorter holding times). The on-site coordinator will notify the laboratory of impending sample delivery the day the samples are to be delivered.

4.5.4 Field Logbook

A record of sample identification, sample collection and field measurements will be maintained in a field logbook. Specific requirements for the logbook are discussed in detail in Section 2.5.7 of this document.

4.6 Analytical and Quality Control Procedures

The selected laboratory will be certified through the State of California DHS' ELAP and will have a documented QA Program that complies with EPA guidance document QAMS-005/80. The laboratory selected will be required to allow access by EPA's authorized representatives to the laboratory and personnel utilized by the laboratory for analyses.

4.6.1 Analytical Procedures

Del Mar Analytical, located in Irvine, California, will provide analytical services during the field investigation. Data validation performed on groundwater and QC samples collected during recent investigations at other local CERCLA sites indicated that laboratory performance was acceptable. VOCs in soil and groundwater samples will be analyzed by EPA Method 8260, which utilizes GC/MS methodology. With GC/MS methods, second column confirmation is not required because individual compounds are positively identified through the unique mass spectra that are generated. Sample preparation for soil and groundwater samples will be in accordance with EPA Method 5030. As previously discussed in Section 2.1, California EPA does not require the use of EPA Extraction Method 5035, therefore, there is only one local laboratory which currently provides this service. Due to past performance concerns, this laboratory was not selected for analysis of the Phase 1a investigation soil samples. Field preservation using methanol is considered impractical due to the need to handle and weigh soil and hazardous fluids. In addition, field preservation dilutes the sample and increases the reporting limit 50 times. For these reasons, EPA Method 5030 has been specified for all soil samples. VOCs in soil gas samples will be analyzed using EPA Method TO-14, also a GC/MS method.

All method-specific quality control measures, such as external and internal standard calibration procedures, instrument performance verifications, quantitation using method of standard additions, etc., which are suggested within any referenced method (e.g., gas chromatograph [GC] methods in SW-846) must be performed. Table 4-2 presents a list of target analytes and their respective target reporting limits for the VOC analyses for groundwater, soil and soil gas samples. Container types, sample volumes, preservatives, special handling and analytical holding times for each parameter are indicated below:

<u>Analytical Parameter</u>	<u>Media</u>	<u>Method</u>	<u>Preservative</u>	<u>Holding Time</u>	<u>Container Type</u>
Volatile Organics	aqueous	8260	Cool 4° C HCL to pH<2	14 days	3 x 40 mL glass vial, teflon septa, no headspace
Volatile Organics	soil	8260	Cool 4° C	14 days	2" x 6" stainless steel sleeves
Volatile Organics	soil gas	TO-14	None	14 days	Summa canister

In general, the laboratories will adhere to those recommendations as promulgated in criteria described in "Test Methods for the Analysis of Solid Wastes", (SW-846, 3rd Ed.); the Federal Register "40 CFR Part 136", October 1984; and any other method referenced in this plan.

4.6.2 Calibration Procedures

4.6.2.1 Field Calibration Procedures

All equipment used during the field activities will be operated, maintained, calibrated and standardized in accordance with manufacturer recommended procedures. All maintenance and calibration operations will be documented in the field logbook. The serial number or other identification of each piece of equipment will also be recorded in the field logbook so that maintenance and calibration information can be traced back to individual instruments. Each piece of field equipment will have a protocol package that contains, as appropriate, the following:

- Standard Operating Procedures
- Routine preventative maintenance procedures including a list of critical spare parts to be available in the field
- Calibration methods, frequency and description of calibration solutions
- Standardization procedures (traceability to known standards)
- Precision and accuracy assessment procedures

Prior to first use, all field equipment will be checked and calibrated to verify that it is in good working order. Measurement data for water quality parameters will be compared with previous data and if variations exceed 10 percent and cannot be accounted for by changes in field conditions and/or instrument variability, the measuring instrument will be recalibrated and the measurements repeated. If, after recalibration, the variations persist, an alternate measuring instrument will be used to confirm the measurement. For water level measurements, if the difference between the current water level and the historical measurement is greater than 1 foot, the current measurement will be repeated.

4.6.2.2 Laboratory Calibration Requirements

Laboratory calibration procedures will follow protocols specified in the analytical methods. Where there are no specifications, the calibration procedures will follow criteria summarized in Table 4-3. The laboratory will maintain an instrument logbook in order to document all maintenance, repair and calibration records for each piece of equipment.

4.6.3 Quality Control Procedures

This section presents quality control procedures that will be conducted during the field activities to ensure analytical data quality.

4.6.3.1 Field Quality Control Procedures

Field quality control samples are collected and analyzed to evaluate the quality of the field sampling process. Field sampling quality control samples are discussed in Section 2.1.7.

4.6.3.2 Laboratory Quality Control Procedures

A summary of the minimum laboratory quality control requirements and the applicable control limits that are necessary to satisfy the project DQOs are presented in Tables 4-3 and 4-4. All method-specific quality control measures, such as external and internal standard calibration procedures, instrument performance verifications, etc., which are suggested within any referenced method must be performed.

All of the method QC requirements highlighted in this QAPP, as well as all requirements present in the referenced methods, will be followed by the project laboratories. In addition, the laboratories performing the analyses will be required to submit documentation that all of the QC criteria were satisfied for all analyses. The following sections provide a general description of general QC procedures that are typically required in most analyses. In all cases, however, the specific QC requirements referenced in each analytical method must be followed.

Purity of Standards, Solvents and Reagents

All reagents will be of reagent-grade (equivalent) or higher quality whenever obtainable. Organic solvents are to be pesticide-grade or equivalent. Where applicable, reference standard solutions will be traceable to EPA or the National Bureau of Standards (NBS). Each new lot of reagent-grade chemicals will be tested for quality of performance, and laboratory records will be kept to document the results of lot tests. Alternatively, reagent blanks will be prepared from each lot. If method blank contamination is found, the reagent blank will be analyzed to evaluate the source of contamination.

Analytical QC Samples

Laboratory "Reagent-Grade" Water

Laboratory grade water is generally prepared by a special deionized water system augmented by individual filter cartridges and polishers located at each outlet point. The polishers include special particulate filters, organic resins and inorganic resins.

Distilled/deionized water may also be used. Laboratory grade water will be tested so as to demonstrate that it is free of contaminants at levels below the detection limits for the applicable analytical procedures.

Method Blank

A laboratory grade water blank is analyzed along with all aqueous and nonaqueous samples submitted for analyses. The method blank is processed through all procedures, materials, reagents and labware used for sample preparation and analysis. The frequency for method blank preparation and analysis is a minimum of 1 per 20 field samples or per analytical batch, whichever is most frequent. An analytical batch is defined as a maximum of 20 samples from one project that are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch are to be of similar composition or matrix. Specific requirements are outlined in the applicable methods. A summary of laboratory QC requirements is presented in Table 4-3.

Calibration Standards (Initial Calibration)

The calibration standard is prepared in the laboratory by dissolving a known amount of pure (nominally 100%) analyte in an appropriate matrix. The final concentration calculated from the known quantity is the true value of the standard. All calibration standards must be traceable to certified reference materials or certified check standards. The results obtained from these standards are used to generate a standard curve which can be used to quantify the compound in the environmental sample. Five calibration standards and a blank are generally used when generating a calibration curve for organic analyses. However, three calibration standards and a blank are required when analyzing soil gas samples using EPA Method TO-14. For organic analyses using GC/MS methodology, a relative standard deviation (RSD) of the calibration factor (defined in method) of less than 30 percent for all calibration check compounds (CCCs) and less than 15 percent for all other target analytes is required before initial calibration is accepted. Method TO-14 requires an RSD of the response factor of less than 30 percent for all target analytes before initial calibration is accepted.

Check Standard (Continuing/Daily Calibration)

The check standard is prepared in the same manner as a calibration standard. The final concentration calculated from the known quantity is the true value of the standard. The check standard is not carried through the same process used for the environmental samples as it does not undergo the sample preparation procedure. The check standard result is used to monitor the continuing validity of an existing calibration curve or concentration calibration standard file. Continuing calibration standards must satisfy method-specific QC requirements prior to initiation of sample analysis.

Quality Control Check Samples

The QC check sample is a reference standard acquired from an EPA-approved source (e.g., EPA Standards Repository, NBS) that is analyzed "as is" or diluted according to instructions provided with the reference material, to provide independent verification of instrument calibration. Quality control check samples for most types of analyses are available from EPA Cincinnati free of charge, and will be used at a specified frequency as a means of evaluating the analysis techniques.

QC check samples will be analyzed at the frequency specified in the referenced protocols or at a minimum of each time a new calibration curve is established. Corrective action in the form of re-analysis of all associated samples is required if a QC check sample is outside control limits. The control limits are typically a recovery of ± 10 percent of the true value except when the established limits provided by the supplier of the standard reference material are different. Applicable control limits must be provided with the data.

Control Samples

The Laboratory Control Sample (LCS) is a type of QC check sample (i.e., reference standard) that is carried along with the samples through the entire sample preparation/analysis sequence. Solid matrix control samples are to be digested/extracted and analyzed when applicable and as available. The frequency for the inclusion of control samples is 1 per 20 or as stated in the referenced protocols.

Spikes

A sample matrix spike is prepared by adding a known amount of the pure analyte to the environmental sample before extraction/digestion. The added analyte is the same as that being assayed for in the environmental sample. An analytical spike is prepared by adding a known amount of analyte(s) to a known amount of sample digestate or extract.

Background and interferences having an effect on the actual sample analyte will have a similar effect on the spike. The calculated percent recovery of the matrix spike is considered to be a measure of the relative accuracy of the total analytical method, i.e., sample preparation and analysis. The calculated percent recovery of the analytical spike is considered to be a measure of the relative accuracy of the sample analysis procedure only. Matrix spikes and surrogate spikes also provide a measure of the effect of the sample matrix has on the ability of the methodology to detect specific analytes. When there is no change in volume due to the spike, it is calculated as follows:

$$\%R = 100(A-X)/T$$

Where:

%R	=	Percent Recovery
A	=	Measured value of analyte <u>after</u> spike is added
X	=	Measured value of analyte concentration in the sample <u>before</u> the spike is added
T	=	Value of spike

Tolerance limits for acceptable percent recoveries are established in the referenced methods and are summarized in Tables 4-3 and 4-4. Project-specific QC acceptance limits may be established on a parameter-specific basis for each analysis method if after sufficient data have been compiled it is apparent that different limits than those specified in the referenced methodology should be applied.

Matrix spikes will be analyzed at a minimum frequency of 1 per 20 samples of similar matrix or analytical batch.

Matrix Spike Duplicate

Matrix spike duplicate samples are required at a specified frequency of 1 per 20 samples. A matrix spike duplicate is prepared from a second aliquot of the sample that was analyzed as the matrix spike. The RPD value between the matrix spike and the matrix spike duplicate for each spike analyte must be reported. The RPD control limits are defined in Table 4-4.

Surrogate Spikes

For organic analyses, every sample is spiked before extraction/analysis with a surrogate mixture of compounds which are considered to behave similarly during analysis, but are not identical to analytes potentially found in naturally-occurring sample matrices. Specific requirements are outlined in the analytical method. Acceptance limits are defined in Table 4-3.

Laboratory Duplicate Sample

Aliquots (e.g., subsamples) are made in the laboratory of the same sample, and each aliquot is treated exactly the same throughout the analytical method. The RPD between the values of the duplicates, as calculated below, is taken as a measure of the precision (reproducibility) of the analytical method:

$$\text{RPD} = (D_1 - D_2) / [(D_1 + D_2) / 2] \times 100$$

Where:

RPD = Relative Percent Difference
D₁ = First Sample Value
D₂ = Second sample value (duplicate)

The duplicate is a measure of the precision of the laboratory sampling (i.e., aliquoting) and analysis procedure and of the homogeneity of the sample matrix as provided to the laboratory. For most organic analyses, the matrix spike duplicate can be used to fulfill the requirement for a laboratory duplicate.

Mass Spectrometer Tuning Solution

Proper operating configuration of the instrument and data system is performed using a mass spectrometer tuning solution. Mass calibration and resolution, and instrument stability are demonstrated using the tuning solution prior to initial calibration. Mass ion abundances must meet the criteria specified in the appropriate methods.

4.6.3.3 Laboratory Custody Procedures

Laboratory custody will conform to procedures described in Section 4.5.1.4.

4.6.4 Preventive Maintenance

Instrument maintenance logbooks will be maintained in the analytical laboratories at all times. The logbooks in general contain a schedule of maintenance, as well as a complete history of past maintenance, both routine and non-routine.

Preventive maintenance shall be performed according to the procedures delineated in the manufacturer's instrument manuals, including lubrication, source cleaning, detector cleaning, and the frequency of such maintenance. Chromatographic carrier gas purification traps, injector liners, and injector septa shall be cleaned or replaced on a regular basis. Precision and accuracy data shall be examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance shall be performed when an instrument begins to degrade as evidenced by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet one or another of the quality control criteria.

For field equipment, preventative maintenance shall be carried out in accordance with procedures and schedules specified by the manufacturer. In general, all field equipment shall be wiped clean at the end of each day, the probes (pH or EC) and all turbidity vials shall be thoroughly rinsed with deionized water. All pH probes shall be stored according to the manufacturer's instructions. To minimize down-time, extra probes and batteries shall accompany field equipment.

4.6.5 Acceptance Criteria for Supplies and Consumables

Critical supplies and consumables that may directly or indirectly affect the quality of the field data generated during the Phase 1a investigation activities and their acceptance criteria are as follows:

Supply/Consumable	Acceptance Criteria
Calibration gases for the PID (100 ppm)	± 5 ppm
pH buffer solutions (4, 7 and 10)	± 0.05 pH units
Turbidity meter calibration standard	± 0.1 NTU
Purified water used in decontamination activities	Non-detectable concentrations of target analytes (i.e., VOCs)
Sample containers	Non-detectable concentrations of target analytes (i.e., VOCs)
Laboratory reagents/glassware	Non-detectable concentrations of target analytes (i.e., VOCs)

In lieu of independent acceptance testing, the manufacturer or supplier of each calibration standard, buffer solution, and purified water listed above will be required to provide documentation with each shipment indicating the consumable's specifications (i.e., accuracy limits, purity, expiration dates, etc.). This documentation and the consumables themselves (when not being used) will be maintained/stored in the field equipment supply room, located at CDM's Irvine, California office, and will be checked prior to use. Expiration dates, purity and/or accuracy limits will be recorded in the field logbook.

The analytical laboratory will be responsible for maintaining, documenting and tracking certificates of analysis or specifications for sample containers, and laboratory reagents and glassware used during the analysis of the environmental samples.

4.7 QA/QC Samples

QA/QC samples which will be collected during the course of the Phase 1a investigation will consist of the following types as described below: duplicate samples and decontamination rinsate blanks.

4.7.1 Duplicate Samples

At a minimum, duplicates of groundwater samples will be collected at a rate of 10 percent of the samples collected. Duplicate samples will be collected, preserved, packaged, labeled, and sealed in manners identical to the other samples being collected. Duplicates will be collected from wells where moderate levels of contamination are anticipated. Duplicate groundwater samples will be collected as splits. For example, a duplicate groundwater sample will be collected by splitting the sample between sample containers. Duplicate soil gas samples will be collected by filling a second Summa canister immediately after the original sample is collected. It is anticipated that one duplicate groundwater sample and one duplicate soil gas sample will be collected during implementation of the Phase 1a field program.

Due to the inherent heterogeneous nature of soil matrices and the fact that it is not possible to collect a true duplicate soil sample using split-spoon sampling methodology, neither duplicate nor co-located (sample collected immediately above or immediately below the sample depth) soil samples will be collected during Phase 1a field activities.

4.7.2 Decontamination Rinsate (Equipment) Blanks

Decontamination rinsate blanks will be comprised of the final rinse water from decontamination of equipment. The blank is prepared in the field by pouring distilled water through the sampling equipment and into the appropriate sample containers after equipment decontamination. The rinsate blank serves as a check to verify the effectiveness of decontamination procedures. Two blanks will be collected during drilling to document the effectiveness of split-spoon sampler decontamination (one from the deep well and one from the first shallow well drilled). One blank will also be collected during groundwater sampling to document the effectiveness of the factory cleaning process on the disposable bailers used for sample collection. Decontamination rinsate blanks will be analyzed for VOCs by EPA Method 8260.

4.7.3 Laboratory QC Samples

Laboratory QC samples will be collected for soil and groundwater samples at a frequency of one per 20 samples. For groundwater samples, double sample volume will be collected. These additional sample containers will be labeled "for matrix spike/matrix spike duplicate (MS/MSD) analysis" and will be used by the laboratory for their internal quality control. Samples for laboratory QC will be selected from locations where low levels of contamination are expected (as determined by field screening methods or historical data). Selection of QC samples with low, rather than moderate to high, levels of contamination will minimize the potential of diluting out the spike concentration. Laboratory QC samples will be designated on the chain-of-custody record. Analysis of MS/MSD samples is not a required QC element for the analysis of soil gas samples analyzed by EPA Method TO-14. Rather, an LCS and its duplicate are utilized to assess precision in EPA Method TO-14.

4.8 Equipment Decontamination Procedures

All reusable field equipment used to collect and handle samples, or collect field measurements, will be decontaminated before coming into contact with any sample for laboratory analysis. The decontamination procedure will match the degree of contamination on the sampling tool. Sample collection equipment will be decontaminated before first use and between each sample.

All equipment used for drilling and well installation operations will also be decontaminated before first use and between use at each boring location. Large-scale decontamination will consist of a thorough cleaning using a high-pressure steam cleaner, and potable water. Portable decontamination areas will be established for cleaning equipment between sample locations. General decontamination procedures for sampling equipment are as follows:

- A supply of tap water of drinking water quality will be required for equipment decontamination. It is anticipated that the water will be obtained from local fire hydrants and faucets, as provided by the water purveyors to the local areas. A sample of the hydrant water will be collected for laboratory analysis of VOCs in order to document the quality of the water used for equipment decontamination purposes.

- The drilling contractor will be required to provide a decontamination station to steam clean all heavy equipment (e.g., drill rig, drill pipe, augers, bits, portable mud tanks, shale shaker, packer assembly, test pumps, etc.). Fluids generated by the decontamination operation will be contained in a Baker tank or other appropriate container.
- Ample amounts of tap water with a detergent (Alconox or equivalent) will be used to wash reusable sampling equipment, which will be rinsed thoroughly with tap water, checked for any residual dirt, and rewashed if necessary.
- The item will be rinsed twice with tap water, followed by a deionized/distilled water rinse.
- The item will be allowed to air dry and will be covered or wrapped in plastic, if not immediately used.
- Large items (i.e., casing, drill pipe, augers, drill bits, etc.) will be steam cleaned and placed on clean polyethylene sheeting or sawhorses and allowed to air dry.

All equipment decontamination procedures and events will be recorded in the field logbook. All liquids generated from decontamination procedures will be contained on-site in 55-gallon drums or in Baker tanks.

4.9 Quality Assurance Oversight

4.9.1 Audit Procedures

Field performance audits will be the responsibility of the QA manager and will be conducted as presented in the following paragraph with additional audits performed if problems are discovered. Performance audits are quantitative checks on different aspects of internal support or project work, and are most appropriate for environmental sampling and analysis activities.

The QA manager will select personnel to perform the CDM field audit(s). A field performance audit will be performed on an unscheduled basis and will consist of a visit to the field to verify that all QA/QC procedures set forth in this document are being followed. The auditor will compare the sampling, collection and documentation procedures as stated in project documents to what is actually being performed in the field. Discrepancies will be noted and the appropriate field personnel will be notified so that corrections can be made immediately. A formal field performance audit report will be produced and delivered to the project manager and field personnel. A copy will also be submitted to the files. The project manager is responsible for seeing that all recommended corrections occur.

4.9.2 Corrective Action

An important part of a quality assurance program is a well defined, effective policy for correcting problems. The QA program operates to prevent problems, but it also serves to identify and correct those that exist. Usually these problems require either on the spot, immediate corrective action or long term corrective action.

The corrective action system used during the field activities is designed to quickly identify problems, and solve them efficiently. The QA manager is responsible for the direction of this

system and receives full support from management for its implementation. The essential steps are as follows:

- Identify and define the problem
- Assign responsibility for investigating the problem
- Determine a corrective action to eliminate the problem
- Assign and accept responsibility for implementing the corrective action
- Implement the corrective action
- Verify that the corrective action has eliminated the problem
- Document the problem identified, the corrective action taken and its effectiveness in eliminating the problem

Corrective action procedures which will be used to resolve deficiencies found during routine activities or QA audits of field, laboratory or office activities will be as described in the following section.

4.9.2.1 Corrective Action Resulting from Routine Activities

Deficiencies found during normal routine activities will be resolved by implementing corrective action as part of normal operating procedures by staff. Corrective actions of this type will be noted in the field or laboratory log book; no other formal documentation is necessary unless further corrective action is required. If normal procedures do not solve the problem, the staff will document the problem in a formal memo addressed to the QA manager and copied to the project file.

4.9.2.2 Corrective Action Resulting from QA Audits

Deficiencies encountered during a QA audit will be corrected as soon as possible. The QA manager, with the project manager, is responsible for completion of appropriate corrective action. The procedures used to expedite corrective action will be:

- Auditor verbally notifies the QA manager and field personnel immediately during audits of deficiencies found
- QA manager institutes corrective action as soon as possible
- QA manager distributes the audit report promptly

4.9.3 Reports to Project Management

All project staff will be responsible for maintaining constant communication with the Project Manager and for identifying any issues that may affect the usability of the data and the decisions that are based on the data. Project management will be kept informed through daily verbal and/or written communication. The QA Manager will monitor laboratory performance and compliance

with quality assurance requirements. The laboratory will be subject to an onsite audit if necessary. Results of such audits will be documented and placed in the project files.

4.10 Data Verification, Validation, Usability and Reporting

The following sections discuss the overall verification and validation process that will be implemented for data generated during the Phase 1a field investigation. The verification process involves the evaluation of the data with respect to SOPs and project requirements, whereas the data validation process involves the evaluation of the technical usability of the data. The results of the data validation will determine the level of uncertainty associated with the analytical results to be used in the decision-making process. Reduction of laboratory measurements and laboratory reporting of analytical parameters will be in accordance with the procedures specified for each analytical method (i.e., perform laboratory calculations in accordance with the method-specific procedure). The requirements set forth in Tables 4-1 through 4-4 of this QAPjP will be used as the basis for data validation.

In addition, Table 4-1 presents the deliverable requirements for each method that must be provided as the laboratory sample deliverable in order to completely satisfy the reporting criteria. EPA Data Validation Functional Guidelines (1994) will be used in conjunction with the above sources to establish analytical data quality. All method deviations and reporting or calculation variances will be fully documented by the project lab. Analytical parameters shall be reported in the concentration units associated with the analyte reporting limits listed in Table 4-2. Technical personnel from CDM qualified in data validation procedures will be responsible for data verification and validation.

4.10.1 Data Verification

Data quality and utility depends on many factors, including sampling methods, sample preparation, analytical methods, quality control, and documentation. Subcontractors, such as laboratories, must be advised of all applicable documentation and procedural requirements. Once the data are assembled, satisfaction of all validation criteria will be documented as listed below. Chemical data must meet criteria of: (1) quantitative statistical significance; (2) custody and document control; and (3) sample representativeness. Physical data include: (1) sampling location, time, and personnel; (2) documentation; and (3) methodologies. Data validation and assessment of analytical data will be performed by technical personnel from CDM, under the supervision of the QA manager.

Documentation may be either direct (e.g., listing of dates, names, methodologies, etc.) or by reference to existing documents. Any reference documents will be specifically identified. The precise and retrievable location of nonstandard documents (e.g., in-house procedures manuals, chain-of-custody forms, laboratory reports) will be stated.

To determine the quantitative statistical significance of chemical data, the following items will be documented as appropriate (e.g., with laboratory records, laboratory standard operating procedures by reference to an approved SOP manual, or with equipment manufacturer/supplier records):

1. Laboratory/field instrumentation, including calibration data, standard methods and references.
2. Proper sample bottle preparation.

3. Laboratory analysis methods, including reference methods.
4. Laboratory analysis detection limits.
5. Verification of standards using EPA or NBS reference materials.
6. Analysis of laboratory blanks, spikes, duplicates, etc., as specified herein.
7. QC limits shall be consistent with the limits specified in Tables 4-3 and 4-4.
8. Analysis of field duplicates, blanks, and other field QC sample types as specified herein.

To evaluate the custody and document control for samples and results, the following items will be documented:

1. Field custody noted in field logbook or transfer-of-custody documentation for sample collection, handling, and shipment.
2. Laboratory custody documented by transfer-of-custody documentation from either field personnel or shipper.
3. Laboratory custody documented through designated laboratory sample custodian with secured sample storage area.
4. Traceability of sample designation number(s) through entire monitoring system.
5. Maintenance and storage of all field notebooks, laboratory data, and all custody documents.
6. Completion of all forms and logbooks (indelible ink without alterations except as crossed-out [not erased] and initialed).
7. Identity of sample collector.
8. Dates of sample collection, shipping, and laboratory analysis.

In some cases, the handling of a sample while in the custody of one individual may not be properly documented. In addition, written documentation of transfers of custody between two individuals may be lost. In such cases, it may be necessary to rely on the custodian's verbal testimony that the sample remained secure or that a transfer was made to another individual. If there is any chance that the custodian's testimony will be seen as unreliable, the data produced as a result of that sample may be rejected.

The existence of appropriate and proper documentation associated with a sample's analysis may be judged as acceptable in a court of law; however, the possibility exists that individual testimony as to the proper application of all procedures may be required as well.

To determine sample representativeness, the following items must be checked:

1. Compatibility between field and laboratory measurements or suitable explanation of any discrepancy.
2. Sample preservation technique and holding time.
3. Sample storage within suitable temperature, light, and moisture conditions.
4. Use of proper sample containers (e.g., inert for the parameter(s) of interest).
5. Use of proper sample collection equipment.
6. Use of proper decontamination procedures.
7. Use of proper laboratory preparation techniques (e.g., aliquoting, digestion, extraction).
8. Evaluation of proper sample site selection criteria to provide representativeness.

To evaluate the physical data that support the analytical data, the following items will be documented.

1. Sampling date and time.
2. Sampling team; observation taker and recorder, team leader.
3. Sampling location and physical description (e.g., private or public, asphalt, concrete or soil, industrial, commercial or residential, monitoring well type, etc.).
4. Sample depth increment for soil and soil gas samples.
5. Sample collection techniques.
6. Field preparation techniques (e.g., compositing, phase separating, etc.).
7. Visual classification of sample using the USCS.

In addition, sample calculations will be performed as required by the Functional Guidelines (EPA 1994) and data will be checked for transcription errors from the raw data to the final reports.

4.10.2 Data Validation Procedures

There are several types of data that have the potential to be used during the Phase 1a field investigation. These data types include:

- Groundwater quality data from the existing monitoring well
- Groundwater quality data from all newly-installed monitoring wells
- Water level, wellhead elevation and screen interval depth, or elevation, data for all wells (existing and new) from which water quality data are used

- Lithologic data
- Aquifer test data

4.10.2.1 Data Validation of New Data

Formal data validation will be performed (as per the Functional Guidelines [EPA 1994]), and the requirements of this QAPjP on 10 percent of the laboratory data generated during the Phase 1a field program. The data to be validated will be selected to obtain an evaluation of all types of analytical results at critical locations and times. Based on the 10 percent review, a data validation report will be completed. If the 10 percent review indicates significant quality problems, additional data validation will be recommended in the report and subsequently performed. Significant quality problems can include, but are not limited to, holding time exceedances, QC samples that are outside of the specified control limits or frequencies, detection of common laboratory contaminants at greater than five times the method detection limits (MDLs), or other indications that the laboratory may not be adhering to proper quality control protocol. The formal validation procedures are summarized in the following sections. All of the data will be assessed by qualified technical personnel from CDM for overall data usability and accuracy, taking into consideration sample collection, handling, the results of blind QC samples, and results of statistical analyses performed on the data as described above.

QC Documentation

Laboratory data are screened for inclusion and frequency of the necessary QC supporting information (detection limit verification, initial calibration, continuing calibration, reagent blanks, duplicates, spikes, etc.). QC information not included or of insufficient frequency is cause to designate the affected measurement data as questionable or invalid. Requests for reanalysis for additional QC-supporting information can be made at this point. Data validation checklists for organic analyses are included in Appendix E of this SAP

Corrective Action

QC supporting information is then screened for QC data outside established control limits, and if out-of-control data are discovered, the specified appropriate corrective action is also obtained from the supporting information. Certain out-of-control data without appropriate corrective action are cause to designate the affected measurement data as questionable or invalid. Requests for reanalysis can be made at this point.

As defined in the referenced methods, automatic corrective action must be taken by laboratories for specified out-of-control instrumental QC checks and for method blanks. Recalibration is required of any instrument until it meets calibration criteria; and reanalysis of the associated samples is required for out-of-control blanks, QC Check Samples, the LCS, surrogate spike recoveries, and internal standard responses. The laboratory is required to establish MDLs for all parameters annually and to demonstrate that the specified MDLs are attained. The laboratory is required to report the results to the level of the established MDL. Corrective action is required for all types of methods used if any of the above QC measures do not meet criteria as specified in the applicable method or this QAPjP.

Organic analytes found in method blanks are required to be less than the MDLs, except as specified for certain common laboratory contaminants. Common laboratory contaminants may be present at up to five times the MDL. Re-analysis is required of any samples associated with an out-of-control method blank if the reported concentration in the samples of a specific analyte, which was also found in the blank, is less than ten times the amount found in the blank.

For all other QC samples, either a flag or no corrective action is specified. This includes:

- Serial dilution
- Holding times
- Common laboratory contaminants found in organic blanks
- Matrix Spikes, duplicates, and matrix spike duplicates
- EPA-approved standards

Therefore, if QC data are outside established control limits and it is recognized that the laboratory is operating per protocol and no error or anomaly has occurred during sample preparation and analysis, the only meaningful corrective action is re-analysis. The existence of out-of-control, qualified results does not automatically invalidate data. This latter point is repeatedly emphasized in "Functional Guidelines for Data Validation" (EPA 1994) and is inherently acknowledged by the very existence of the data validation/flagging guidelines.

The goal to produce the best possible data does not necessarily mean producing data without QC qualifiers. Some qualifiers can provide useful information. Data qualifiers are listed in Appendix E of this SAP.

Database QC

Validated data and appurtenant precision and accuracy statements will be entered into the project database. Duplicate data entry or item-by-item independent entry checks shall be performed as a quality control check of entry accuracy. Computer programs are used to report and store analytical data. Entry accuracy is checked by checking all output and comparing it against the validated data. Hard copies of the computer database will be printed and the information will be manually checked against the laboratory report. As each database entry is checked, it will be highlighted. At the completion of the accuracy check, the hard copy will be filed as a checkprint to serve as verification of the check.

4.10.2.2 Data Validation of Field Measurement Data

Review of data obtained from field measurements (e.g., pH, turbidity, EC, and temperature) taken during the field activities will be performed by the project chemists, geochemists, geologists, or other qualified personnel and the field manager. Validity of all data will be determined by checking calibration procedures utilized in the field as appropriate, and by comparing the data to previous measurements obtained at the specific site. Large variations (greater than 10 percent from historical measurements) will be evaluated in association with changes in local soil conditions and general trends. Variations in data which cannot be explained will be assigned a lower level of validity and will be used for limited purposes. The project chemists, geologists, or geochemists and the field manager will summarize the data obtained from field measurements and will include this information in field logbooks.

4.10.3 Data Usability

Once the data have been verified and validated, the data will be evaluated to determine whether the DQOs have been satisfied. The data usability process will determine whether the data meet the assumptions under which the DQOs and the data collection design were developed. If the data do not support the underlying assumptions, then corrective action must be taken. Corrective action may include collecting additional data that fill in data gaps so that future decisions can be made.

Data generated during the Phase 1a field investigation will be used as input to select and design an appropriate remedy for the Omega Chemical Superfund Site. Prior to any data interpretation or risk screening, the data will be evaluated with respect to QA/QC results. Specifically, the data will be examined with regard to data qualifiers assigned during the data verification and validation process. Data qualifiers will be evaluated to determine their effect on data quality. If data verification or validation indicates that a particular result is unusable, the data will be rejected and not used during the data interpretation or risk screening process. If data verification or validation indicates that a result is estimated, the result may be used, but with caution, to assist in the data interpretation or risk screening process.

The usable analytical and field data will then be utilized in the interpretation of contaminant trends and hydraulic information, including groundwater flow direction and potential rate of flow. The usable data will also be used in the process of identifying ARARs and in the SRE planning. If the data interpretation process does not yield sufficient information to select and design an appropriate remedy for the site, then additional data collection activities will be conducted under a Phase 1b investigation.

4.10.4 Final Reporting and Report Archival

Upon successful completion of the data validation process and assessment of usability of the data, new data generated for the project will be entered into the project database. Data will be available for analysis by the project manager and other authorized personnel.

Copies of all analytical data and/or final reports are retained in the laboratory files and, at the discretion of the laboratory manager, data will be stored on computer disks for a minimum of six months. Subsequent to completion of the project, the files will be transferred to data archives. Data may be retrieved from archives, upon request. CDM will be responsible for record retention at the completion of the Phase 1a investigation.

All data generated during the course of this program will be provided to EPA in both paper and electronic formats for incorporation into the existing EPA database. The electronic files will include, but are not limited to, hydrogeological data, chemical analytical data, aquifer test data, water level data, and sample locations.

Section 5

Data Management Plan

The data management requirements as listed herein provide procedures necessary to properly document, track and manage, and store all field and laboratory data generated during the course of the Phase 1a investigation. The database developed for the Omega Phase 1a investigation and subsequent site investigations will be consistent with the database developed in concert with EPA for the San Gabriel Basin.

5.1 Analytical Database

The primary objective of developing an analytical database is to ensure that a detailed record of data collection, analysis, verification and reporting is maintained. In particular, environmental sampling data need to be stored within a medium that allows for accurate and appropriate manipulation for the purposes of handling, evaluation, accessing, and reporting. Management of analytical data will be the responsibility of CDM. The project database will be developed and maintained using Microsoft Access®, or equivalent, database management system.

File format compatibility with existing EPA data reporting requirements will be maintained to provide efficient transfer of information. Access® provides a flexible database management environment and allows importing from and exporting to a variety of other software packages. Electronic analytical data will be provided by the laboratory so that the data can easily be imported into the project database.

Data appended to the project database will be subjected to a rigorous QC check. The laboratory will be required to submit analytical results as hard copies as well as in electronic format. Prior to transferring to the database, the electronic data will be printed out and a 100 percent check will be performed against the hard copies. If any errors are noted, the laboratory will be contacted and the discrepancy resolved. If required, any corrections will be made to the electronic file before it is appended to the project database.

Backups of the project database will be performed whenever it is changed to minimize the possible loss of data in the event of system failure/corruption. Routine backups will be saved as an archive file.

5.1.1 Data Inclusions

The types of data to be included in the development and management of the comprehensive database include the following:

- Soil, soil gas and groundwater analytical data from new monitoring well installations
- Newly-installed and existing monitoring well construction details (including wellhead elevation and screen interval depth)
- Water level data from existing and newly-installed wells

5.1.2 Database Structure

Access® uses relational data structures (called tables) to store, retrieve, and relate records. These tables are related through “key fields” containing data common to the associated tables. During database development, it is anticipated that the following data tables will be generated:

- Stations Sampling point location description (this will be designated as the key field)
- Construction Monitoring well construction details (depth, construction date, reference point elevation, perforated interval)
- Quality Lab results, one parameter per record
- Parameter Coded reference table of parameter names, and state and federal MCLs
- Water Level Groundwater elevation data
- Laboratory Coded reference table of laboratory information (name, phone number, etc. of laboratory)

A description and structure of the fields included in each of these tables is included in the following sections. The table formats provided herein are examples only. The database may change, grow, and evolve over time as additional needs and uses of the database are identified to fulfill the data management requirements. Data tables and/or fields may be deleted or added during database development, if needed.

5.1.2.1 Stations Database Table

STATIONS is the key element of the database. It contains description information for sample collection stations. Only one record will exist for each station, uniquely identified by the Station_id field. Every laboratory result will be tied to a specific station.

Example field descriptions for STATIONS are as follows:

<u>Field Name</u>	<u>Field Description</u>
Station_id	Unique station identifier, used to tie samples to their corresponding locations.
Station_type	Station type code.
Station_desc	Description of station characteristics, location, or unique features.

Key field relationship between STATION and other tables are as follows:

<u>Field Name</u>	<u>Related Table</u>	<u>Relationship</u>	<u>Comments</u>
Station_id	Quality	One to many	Ties one sample station location to multiple samples
Station_id	Construction	One to one	Ties well construction details to one station_id
Station_id	Water Levels	One to many	Ties one sample station location to multiple water level elevation data.

5.1.2.2 Construction Database Table

CONSTRUCTION contains descriptive information regarding construction details of the monitoring wells.

Field descriptions for CONSTRUCTION are as follows:

<u>Field Name</u>	<u>Field Description</u>
Station_id	Unique station identifier, used to tie construction details to their corresponding wells.
Ground_elev	Ground elevation of well (in feet above MSL).
Reference_elev	Top of casing or reference elevation at which water levels are measured from.
Depth	Well total depth.
Num_perf	Number of well perforations (for this project, number is expected to be equal to 1).
Top_perf	Depth below ground surface at which perforations begin (feet).
Bottom_perf	Depth below ground surface at which perforations end (feet).
Casing_dia	Casing diameter (inches)
Casing_mat	Material of construction (i.e., mild steel, PVC, or other).
Completion_date	Date of well completion.
X_coord	Easting coordinate (UTM).
Y_coord	Northing coordinate (UTM).

Key field relationship between CONSTRUCTION and other tables are as follows:

<u>Field Name</u>	<u>Related Table</u>	<u>Relationship</u>	<u>Comments</u>
Station_id	Station	One to one	Ties well construction details to one station_id

5.1.2.3 Quality Database Table

QUALITY contains laboratory results for all samples collected at the site during the Phase 1a investigation. One record will exist per parameter/value report for each sample. For example, if a sample is analyzed for 100 different parameters, then 100 records will exist for each associated parameter and reported result.

Field descriptions for QUALITY are as follows:

<u>Field Name</u>	<u>Field Description</u>
Station_id	Unique station identifier, used to link parameter and result value in record to sample location information.
Sample_id	Sample identification as it appears on chain-of-custody record sheet.
Parameter_id	Unique code corresponding to every analytical parameter.
Lab_number	Number assigned to each sample by laboratory.
Lab_id	Unique code assigned to each analytical laboratory.
Value	Analytical result reported by laboratory. If result is non-detected, substitute reporting limit in this field.
Units	Units applicable to reported value.
Det_limit	Detection limit reported by laboratory.
Val_flag_1	Result identifier flag, provided by laboratory. May be a "U" for a non-detected result, a "B" if analyte was also detected in the laboratory's method blank, or left blank.
Val_flag_2	Data assessment qualifier (used at the discretion of database and QA managers)
Val_flag_3	Code to identify sampler
Val_flag_4	Code to identify type of sample. May be left blank, or "N" to indicate an equipment decontamination blank, "P" to indicate a PE sample, "K" to indicate a duplicate sample, or "F" to represent a field blank.
Samp_date	Date the sample was collected.
Ship_date	Date the sample was received by laboratory.
Extr_date	Date the sample was extracted. Field will be left blank for analyses that do not require sample extraction.
Anal_date	Date the sample was analyzed.
Anal_method	Analytical method used for result determination.

<u>Field Name</u>	<u>Field Description</u>
Matrix	Sample matrix (i.e., water, soil, air).
Dil_factor	Sample dilution factor

Key field relationship between QUALITY and other tables are as follows:

<u>Field Name</u>	<u>Related Table</u>	<u>Relationship</u>	<u>Comments</u>
Station_id	Station	One to one	Links sample results to station_id.
Lab_id	Laboratory	One to one	Ties laboratory_id to laboratory name and description.
Parameter_id	Parameter	One to One	Ties lab results to parameter name, MCL

5.1.2.4 Parameter Database Table

PARAMETER is a reference table that associates a chemical parameter code (Parameter_id) present in the QUALITY database table with the parameter name, MCL, group type., etc. Only one record will exist for each parameter name..

Field descriptions for PARAMETER are as follows:

<u>Field Name</u>	<u>Field Description</u>
Parameter_id	Three- or four-character code abbreviation for element/compound.
Name	Name of chemical element or compound.
Synonyms	Other names (Synonyms) for chemical element or compound.
CA_MCL	California MCL.
CA_Units	California MCL units.
EPA_MCL	Federal MCL.
EPA_Units	Federal MCL units.
Group_ID	Chemical group (e.g., VOC, Metal, Inorganic, PCB, etc.) with which parameter is associated.
Comments	Any relevant comments related to parameter (e.g., if CA_MCL is an action level, or if EPA_MCL is a secondary drinking water standard, etc.)

Key field relationships between PARAMETER and other tables are as follows:

<u>Field Name</u>	<u>Related Table</u>	<u>Relationship</u>	<u>Comments</u>
Parameter_id	Quality	One to many	Links unique parameter name to multiple result records.

5.1.2.5 Water Level Database Table

WATER LEVEL contains single or multiple groundwater elevation measurements for individual stations. One record will exist per water level measurement for each station.

Field descriptions for WATER LEVEL are as follows:

<u>Field Name</u>	<u>Field Description</u>
Station_id	Unique station identifier used to tie multiple groundwater elevations to unique station information in STATIONS.
WL_Date	Date that groundwater elevation was taken.
Elev	Groundwater elevation measurement.
WL_Units	Groundwater elevation units.

Key field relationships between WATER LEVEL and other tables are as follows:

<u>Field Name</u>	<u>Related Table</u>	<u>Relationship</u>	<u>Comments</u>
Station_id	Station	Many to One	Ties groundwater elevation measurements to unique station information.

5.1.2.6 Laboratory Database Table

LABORATORY is the reference table that associates three-character abbreviations (Lab_id) with the laboratory name, contact, address, and telephone number. Only one record will exist for each laboratory.

Field descriptions for LABORATORY are as follows:

<u>Field Name</u>	<u>Field Description</u>
Lab_id	Unique identifier used to link laboratory with result listed in QUALITY table.
Lab_Name	Laboratory name.
Lab_Contact	Name of contact at laboratory.
Lab_Address	Street address of laboratory.
Lab_City	City where laboratory is located.
Lab_State	State where laboratory is located.
Lab_Zip	Zip code of laboratory.

<u>Field Name</u>	<u>Field Description</u>
Lab_Phone	Telephone number of laboratory.
Lab_Fax	Facsimile number of laboratory.

Key field relationships between LABORATORY and other tables are as follows:

<u>Field Name</u>	<u>Related Table</u>	<u>Relationship</u>	<u>Comments</u>
Lab_id	Quality	One to Many	Links unique laboratory name to multiple record results.

5.2 Document Storage

5.2.1 Project Files

The central files for the Phase 1a investigation will be located in CDM's Irvine, California office. All project documents, including field and analytical data, analysis records and supporting documentation, and all draft and final deliverables submitted to EPA will be kept in file cabinets.

5.2.2 Laboratory Record Keeping

Copies of all analytical data and/or final reports are retained in the laboratory files and, at the discretion of the laboratory manager, data will be stored on computer disks for a minimum of six months. Subsequent to completion of the project, the files will be transferred to data archives. Data may be retrieved from archives, upon request.

Section 6

References

England & Associates and Hargis + Associates, Inc. 1996. Phase II Close Out Report. Omega Chemical. October 1.

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Appendix A
Community Relations Plan

Contents

<i>Section 1</i>	Introduction	A1-1
<i>Section 2</i>	Mission and Goals	A2-1
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Section A1

Introduction

The purpose of this Community Relations Plan (CRP) is to briefly outline key issues relevant to the proposed Omega Chemical Site Phase 1a Field Investigation, including a brief summary of investigatory activities and remediation actions to date. Potentially interested public(s) within geographic proximity of the site will be identified, as well as a point of contact for citizen questions, and a suggested location for establishing an information repository. This plan involves a community relations approach that is specific to the Phase 1a investigation. However, any activities included in this plan will be designed to tie in with a program-wide CRP to be developed jointly with the U.S. Environmental Protection Agency (EPA) in the future. The Phase 1a investigation is being performed by the Omega Chemical Site PRP Organized Group (OPOG) in cooperation with EPA.

The Omega site is located at 12504 East Whittier Boulevard in the City of Whittier, California. The parcel is approximately 40,000 square feet in area (approximately 1 acre) and is zoned for heavy industrial use (M-1). However, the surrounding area is a mix of industrial, commercial and residential property. As shown on Figure 1-1 of the SAP, adjacent properties include Cal-Air to the north, Terra Pave to the west, and a public roller skating rink (Skateland) to the south. Residential properties are located east of Whittier Boulevard and south of Washington Boulevard. Presbyterian Inter-Community Hospital is located approximately one-quarter mile west of the site. In addition, Whittier College, five elementary schools and two high schools are located within one mile of the site. Several other schools and public parks are located within two miles of the site. Groundwater directly beneath the site can be found approximately 70 feet below ground surface and does not appear to be suitable for use as municipal or domestic water supply based on a higher than acceptable level of Total Dissolved Solids (TDS). The nearest drinking water supply well (City of Santa Fe Springs well 30R3) is located approximately 7000 feet west-southwest of the site. The well is perforated in the intervals from 200 to 288 and 300 to 900 feet below ground surface.

According to a May 1, 1995 EPA memorandum, the Omega site operated as a spent solvent and refrigerant recycling and treatment facility handling chlorinated hydrocarbons and chlorofluorocarbons from 1976 to 1991. During those years, drums and bulk loads of waste solvents and chemicals from various industrial activities were processed to form commercial products. Chemical, thermal and physical treatment processes were believed to have been used to recycle and reuse the waste materials. Wastes generated from these treatment activities included still bottoms, aqueous fractions and non-recoverable solvents.

During the 1980s, several assessments of subsurface conditions were performed, including sampling of soil, gas and groundwater. In 1987, workers removed a 500-gallon underground storage tank. In May 1995, EPA issued Administrative Order 95-15, and work to remove a large number of drums, containers and debris began. This work, as well as decontamination of the surface of the site, was successfully completed by Harding Lawson Associates in September 1995.

The Phase II Investigation began in November 1995 and concluded in September 1996. This Phase included further analysis of the site's geology and hydrogeology, identification of the nature and extent of contamination, and identification of any materials considered to be "grossly contaminated". The only grossly contaminated near-surface soil was contained within the loading dock sump, with a broken and cracked concrete cover. Following the sampling and analysis, grossly contaminated near-surface soil was removed and disposed at an appropriate disposal facility. The Phase II Close Out Report (England & Associates and Hargis + Associates, Inc., October 1, 1996) concluded that a plume of dissolved-phase volatile organic compounds (VOCs) extended approximately 1,700 feet southwest of the Omega site. The primary VOCs detected in the groundwater immediately underlying the site were tetrachloroethene (PCE), freon 113 and 11, trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), methylene chloride, acetone, and chloroform. A summary of groundwater analytical results in the vicinity of the Omega site is illustrated in Figure 1-3 of this SAP.

An off-site groundwater investigation conducted in early 1997 concluded that elevated levels of volatile organic compounds (VOCs) were present in groundwater further downgradient than expected based on groundwater modeling results (see Figure 1-4 of this SAP). The site is located in an industrialized area where VOCs have been detected upgradient and downgradient of other industrial facilities. It is likely that the elevated VOCs detected downgradient from the Omega site are the result of several commingled VOC plumes derived from currently unidentified properties other than Omega Chemical.

The Phase 1a investigation field activities are expected to begin during the second quarter of 1999. Field activities will include the installation of three additional groundwater monitoring wells; the collection of soil, soil gas, and groundwater samples for laboratory analysis; aquifer testing of the newly-installed wells; and data evaluation and preparation of a field investigation summary report.

Section A2

Mission and Goals

The overall mission of the OPOG/EPA effort is to:

- Protect human health and the environment
- Reduce waste and conserve energy and natural resources
- Contain unacceptable levels of waste in soil and groundwater as expeditiously as possible

For Community Relations, as it relates to the Phase Ia field program, the goal is to:

- Create a structure for information to flow both to and from the public
- To provide public(s) within the immediate geographic area of the drilling sites with ample notification regarding the drilling purpose and schedule
- To provide any interested party with the opportunity to ask questions and provide input to the process

For OPOG, achieving this goal will involve:

- Identifying a contact person, telephone number and address for people to call or write with questions or comments
- Developing a one page public information hand-out to provide to give to any members of the public who stop to ask about the ongoing work
- Identifying key public(s) located within one mile of the site and providing them with the same one-page explanation of the Phase 1a work
- Providing this information to the EPA to make available through its Internet web site
- Starting the process of identifying documents to be included in an information repository to be opened during a future phase of this process; the repository will offer easy public access to major project documents

Section A3

Assignment of Project Contact

In order to establish and maintain public credibility, it is important to offer one consistent source for reliable, accurate and timely information throughout the life of the project. For the Omega site, Project Coordinator Chuck McLaughlin with *de maximas, inc.* will fulfil this role.

Chuck McLaughlin
de maximas, inc.
5225 Canyon Crest Drive
Building 200, Suite 253
Riverside, California 92507

(909) 222-0387 phone
(909) 222-0389 fax

All written public information materials developed for this project will include this information, making it possible for the public to have a two-way dialogue about the investigation and remediation effort. Citizens are much less likely to become unnecessarily concerned if they have a system in place that makes it possible to have their questions answered promptly.

In addition, we would suggest that key public information documents be made available through an EPA web site, and that this e-mail address should also be included on all public information documents.

Section A4

Phase 1a Information Document

Although the drilling and other activities for each well will take place in an industrial area, it is possible that citizens may see the field activities and wish to ask questions. But, asking questions of field crews can lead to inadvertent "misinformation" because workers may not be aware of the entire scope of the project. To ensure that accurate, appropriate information is available to the public, a simple one-page explanation of the Phase 1a effort will be provided to workers to give to any citizen who has questions. The Project Coordinator's and Principal Investigator's name and work phone numbers will be included as part of this one-page letter, and a map highlighting the three well locations will also be included. The one-page handout will include information regarding site activities (e.g., drilling, aquifer testing, etc.), anticipated drilling schedule, storage of IDW, and lane closures. A traffic control plan for all wells located in the street will be submitted to City of Whittier staff for approval prior to initiating drilling. The one-page handout will be submitted to EPA for review and approval prior to distribution to the surrounding community. The EPA-approved handout will be distributed approximately one week prior to the initiation of drilling activities. The handout will be distributed to all residences, businesses, etc. within approximately 1,000 feet of each drilling location (i.e., along Putnam Street, E. Pacific Place, Baldwin Place, Washington Blvd., and Whittier Blvd.).

In addition, key public(s) who live, work, attend school or participate in recreational functions within one mile of the Omega site will be provided with the public information document as well. The method of informing these key audiences will be a direct mail letter. A database of addresses for these locations will be developed for potential mailings at future phases of work. The key publics identified for the purposes of this notification (i.e., located within one mile of the Omega site) are:

- Whittier High School
- Whittier Christian High School
- St. Mary's School
- Jackson School
- Laurel School
- Evergreen School
- Wiggins School
- Neighboring Fire Stations
- Any Adjacent Residences/Businesses
- Presbyterian Intercommunity Hospital
- Whittier College
- Skateland Public Roller Rink

The proposed language for this document will be provided to EPA prior to start of the field program. The map to be used to highlight the well locations is included as Figure 2-1 of this SAP.

This document will also be provided to the U.S. EPA to be made available on an EPA Internet Web Site.

Section A5

Development of Information Repository

As work continues, an Information Repository will be required. At this early stage, the Omega Group plans to begin identifying key documents to include in a repository to be opened at a future phase. As a portion of this "set-up phase," we would propose to contact Whittier College for consideration to be used as the repository site. Whittier College is located within two miles of the Omega site, and would be an easily accessible location for the public.

At a future phase, a public announcement of the availability of the repository will be included in a public notice.

Appendix B Field Forms

- Boring Log
- Monitoring Well Development Log
- Monitoring Well Purge and Sampling Form
- Post-Development Water Level Recovery Log
- Aquifer Pump Test Form
- Chain-of-Custody Record
- Example Sample Label

Boring/Well No.:		Site/Location:	
Client:		Project No.:	
Drill Contractor:		Drill Method:	
Date Started:		Date Ended:	Sampling Method:
On-Site Geologist:		RG who Reviewed Log:	Page ____ of ____
Total Depth:		Depth to Water:	Date/Time of DTW Measurement:

Depth (feet)	Sample No. Lab	Blows/Ft	PID FID (ppm)	LEL (%)	USCS	Lithology	Description	Well Construction Detail	Elevation (feet)
5									
10									
15									
20									
25									
30									
35									

Well No.:		Site:	
Client:		Project No.:	
Drilling Contractor:		Geologist:	
Date Started:	Date Ended:		
Well Coordinates:			
Well Location:			

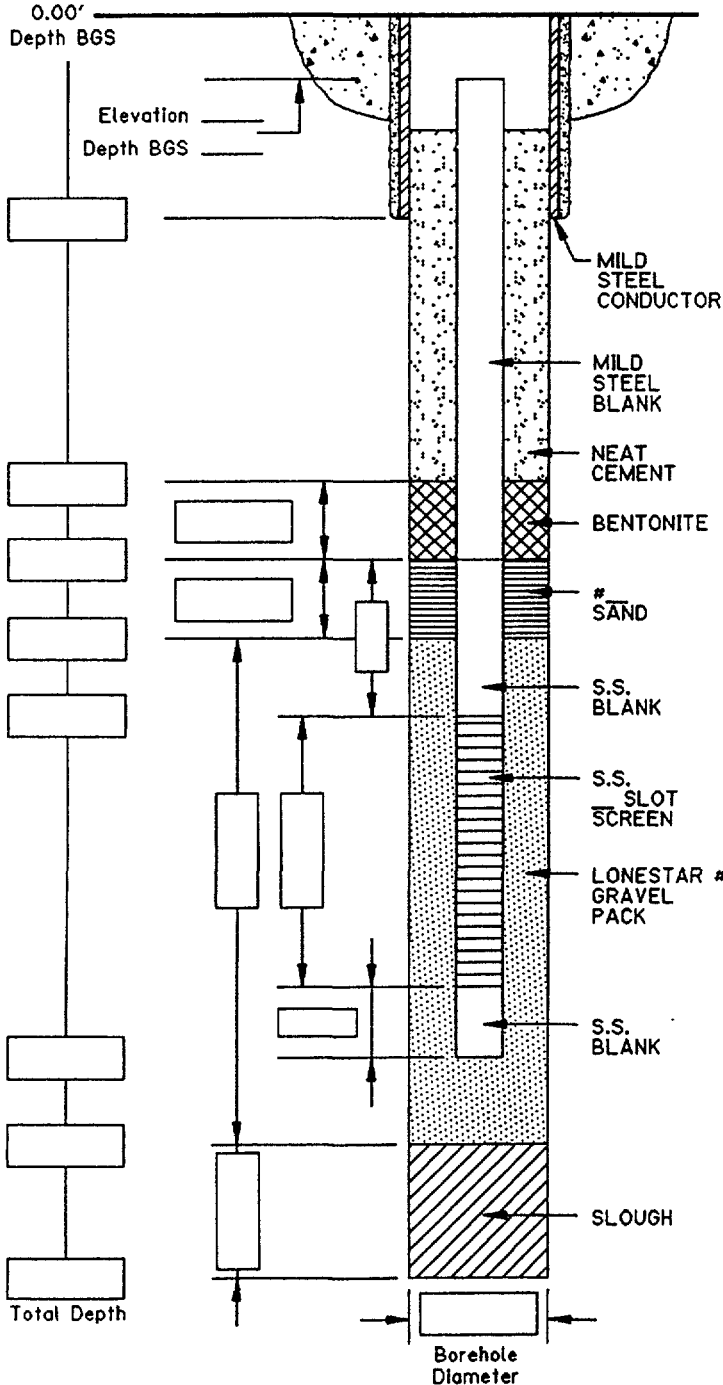
GS Elevation _____

0.00'

Depth BGS _____

Elevation _____

Depth BGS _____



WELL HEAD COMPLETION

Material/Type _____

Diameter _____ Depth BGS _____

CONDUCTOR CASING

Material/Type _____

Diameter _____ Depth BGS _____

SURFACE PAD

Composition & Size _____

RISER PIPE

Type _____

Diameter _____

Total Length (TOC to TOS) _____

GROUT

Composition _____

Interval BGS _____ Tremled (Y / N)

CENTRALIZERS (Y / N)

Depth(s) _____

SEAL(S)

Type _____

Setup/Hydration Time _____

Vol. Fluid Added _____

Interval BGS _____ Tremled (Y / N)

Interval BGS _____ Tremled (Y / N)

FILTER PACK

Type _____

Amount Used _____

Source _____

Interval BGS _____ Tremled (Y / N)

SCREEN

Type _____

Diameter _____

Slot Size & Type _____

Interval BGS _____

SUMP (Y / N)

Type/Description _____

Length _____

Bottom Cap (Y / N) Interval BGS _____

BACKFILL PLUG

Material _____

Setup/Hydration Time _____

Interval BGS _____ Tremled (Y / N)

CDM

environmental engineers, scientists,
planners, & management consultants

MONITORING WELL CONSTRUCTION LOG

Disposition of discharge water _____

[illegible]

POST DEVELOPMENT WATER LEVEL RECOVERY GRAPH

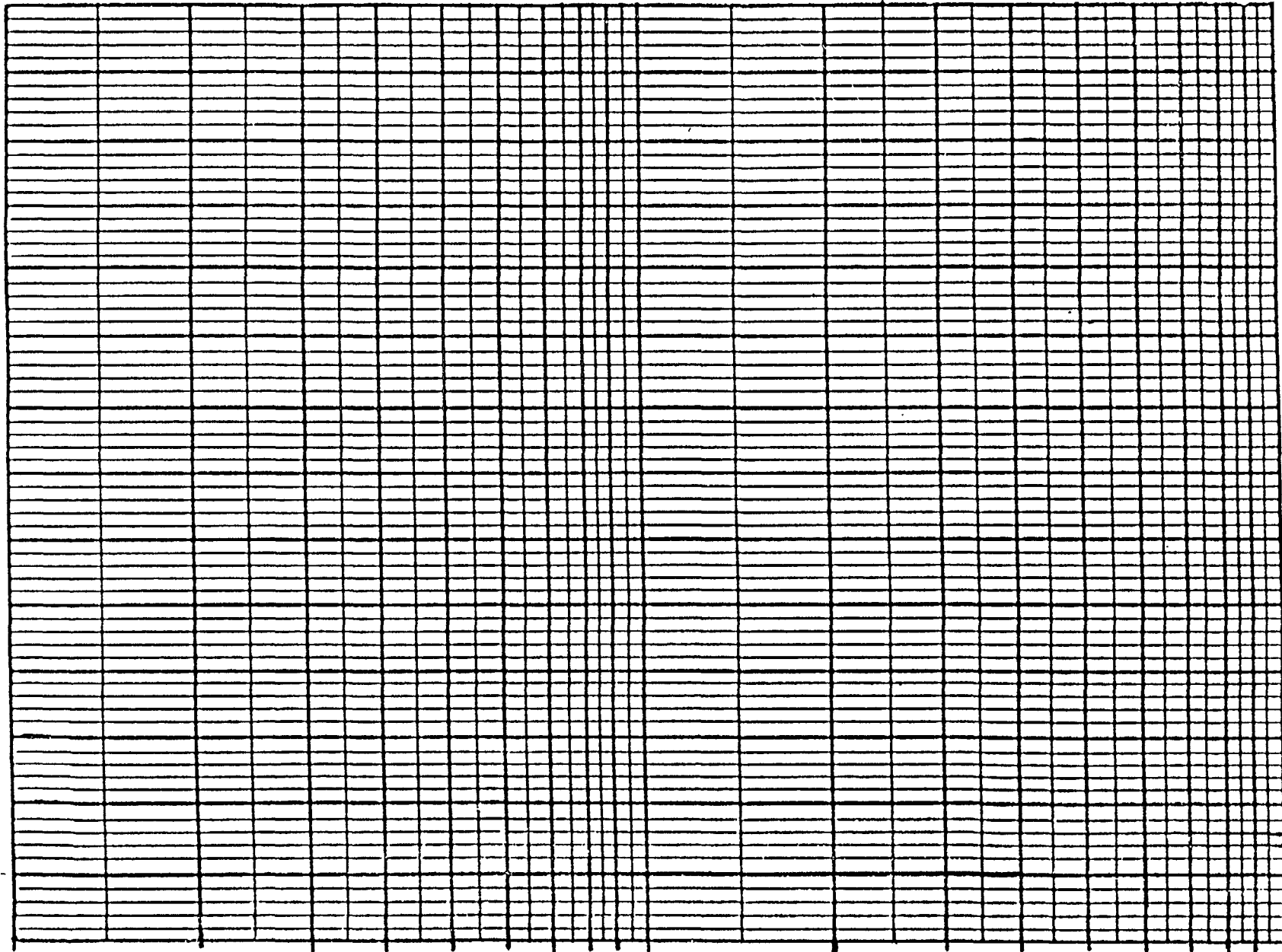
Project Name: _____ Job No.: _____ Well No.: _____ Date: _____

Well Recording Instrument _____

Start Recovery: _____ (: ____m) End Recovery: _____ (: ____m) Total Recovery Time: _____

Beginning WL _____ Final WL _____

DRAWDOWN ()



AQUIFER PUMP TEST DATA

WELL NO. _____

PAGE ____ OF ____

PROJECT _____

[illegible]

CDM

PROJECT NAME _____

PROJECT NUMBER _____

Field Log Book
Reference No. _____[illegible]

CHAIN-OF-CUSTODY RECORD

FIGURE 1

SAMPLED BY (SIGN) _____				
RELINQUISHED BY (SIGN) ① _____ DATE/TIME (/ /)	RELINQUISHED BY (SIGN) ② _____ DATE/TIME (/ /)	RELINQUISHED BY (SIGN) _____ DATE/TIME (/ /)	RELINQUISHED BY (SIGN) ④ _____ DATE/TIME (/ /)	RELINQUISHED BY (SIGN) ⑤ _____ DATE/TIME (/ /)
RECEIVED BY (SIGN) ① _____ DATE/TIME (/ /)	RECEIVED BY (SIGN) ② _____ DATE/TIME (/ /)	RECEIVED BY (SIGN) ③ _____ DATE/TIME (/ /)	RECEIVED BY (SIGN) ④ _____ DATE/TIME (/ /)	RECEIVED BY (SIGN) ⑤ _____ DATE/TIME (/ /)
METHOD OF SHIPMENT _____	SHIPPED BY (SIGN) _____	RECEIVED FOR LABORATORY BY (SIGN) _____	DATE/TIME (/ /)	

Project Name: _____ Sample Date: _____
Project Code: _____ Sample Time: _____
Station No.: _____ Preservative: _____
Station I.D.: _____ Yes _____ No _____
Sample Media: _____ If yes, check appropriate:
Field Filtered: Yes _____ No _____ HCl _____ HNO₃ _____ H₂SO₄ _____
Analysis Requested:
Volatiles _____ Metals _____ Phosphate _____ Nitrate & Nitrite _____ Chloride _____
Fluoride _____ Sulfate _____ Cations _____ TSS _____ TDS _____
Carbonate/Bicarbonate _____ Grain Size _____

Appendix C

Standard Operating Procedures

<i>SOP</i>	<i>Reference</i>
Soil Boring and Rock Coring	1
Subsurface Soil Sampling	3
Well Installation	2
Well Development	2
Groundwater Sampling	2
Duplicate and Split Sample Preparation	3
Chain-of-Custody Procedures	2
Field Logbook	2

¹ Technical Operations Manual. Environmental Management Practice, CDM, July 15, 1993.

² Standard Operating Procedures. Environmental Management Practice, CDM, July 15, 1993.

³ Standard Operating Procedures for Site Characterizations. U.S. Department of Energy, Hazardous Waste Remedial Actions Program, July 1990.

TOM-009
SOIL BORING AND ROCK CORING

1.0 GENERAL

This section provides a discussion of different boring installation methods that can be used. Also included is a section on rock coring and selection of drill hole locations. The purpose of this section is to provide the reader with overall guidance on the installation of borings and not specific procedures. Drilling activities generally will be conducted by a subcontractor.

The selection of the most appropriate boring method must be dictated by the purpose of the boring as outlined in the site specific Sampling and Analysis Plan (SAP). Although this subsection focuses on drilling for sampling purposes, it is important to recognize that borings are also required for in situ testing of subsurface materials and groundwater, and to allow installation of monitoring devices including wells.

The planning, selection, and implementation of any drilling program requires careful consideration by qualified, experienced personnel. At a minimum, the following general steps are required.

- Review of existing site, area, and regional subsurface, geologic, and hydrogeologic information including physical and chemical characteristics. This may include the results of a surficial geophysical survey (TOM-011) or a fracture trace analysis.
- Development of a site-specific health and safety program.
- Definition of the purpose of the drilling and sampling, selection of drilling methods and general site layout, and preparation and execution of the drilling contract.
- Field implementation and decontamination including continuous inspection by qualified, experienced personnel.
- Reporting.

Selection and implementation of soil drilling and sampling methods also require that specific considerations be given to the following issues, which are common to all drilling at or near hazardous waste sites:

- Prevention of contaminant spread, especially vertical migration in the borehole.
- Maintenance of sample integrity.
- Minimization of disruption of existing conditions.
- Minimization of long-term impacts.

2.0 POWERED AUGERS

Powered augers are motor-driven and advanced by a helical worm with sections that can be screwed together. Three types of powered augers are hollow-stem, solid-stem, and bucket augers. The augers themselves are available in sizes ranging from 2 to 48 inches in diameter. The auger can be either hand held or rig mounted. The rig generally does not require additional lifting devices, although a simple hoist and tripod is useful in holes more than 10 feet deep.

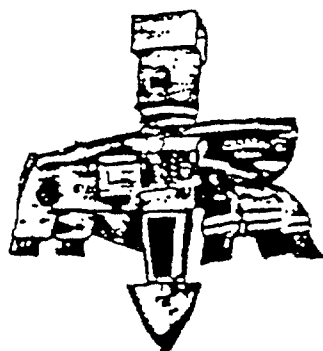
Auger flights are available in several types depending on their intended use. These consist of single-flight earth augers, double-flight earth-rock augers, double-flight rock augers, and high-spiral augers (Figure 1).

The maximum depth of penetration that can be achieved with powered augers is limited by the geologic material, the depth to water, and the length of the drill rod that can be accommodated by the drilling rig. In general, the depth is limited to between 100 and 200 feet. The advantage of auger boring over wash boring, percussion, and rotary drilling is that the cuttings brought to the surface (although disturbed) are generally suitable for positive identification of the soil material but not for precise soil content. Using powered augers also makes it easier to determine the groundwater level. Casing is not generally needed, except when drilling through noncohesive sand and gravel and sometimes when drilling below the water table. Drilling practice has shown that, where applicable, powered auger drilling is preferable to many other methods because the work progresses fast in drilling holes shallower than 100 feet (when intact samples are not required).

2.1 Hollow-Stem Augers

Hollow-stem augers (helical augers) (Figure 2) are a type of powered auger used primarily to advance the borehole when soil sampling is required. The auger shown has a screen section (screened auger) to allow groundwater samples to be collected as the auger is advanced. The hollow-stem auger consists of: (1) a section of seamless steel tube with a spiral flight to which are attached a finger-type cutter seat at the bottom and an adapter cap at the top, and (2) a center drill stem composed of drill rods to which are attached a center plug with a drag bit at the bottom and an adapter at the top. The adapters at the top of the drill stem and auger flight are designed to allow the auger to advance with the plug in place. As the hole is drilled, additional lengths of hollow-stem flights and center stem are added. The center stem and plug may be removed at any time during the drilling to permit disturbed, undisturbed, or core sampling below the bottom of the cutter head by using the hollow-stem flights as casing. This process also permits the use of augering in loose deposits below the water table. Where this technique is used in unconsolidated material below the water table, fluids of known chemical quality may be used to control groundwater inflow. Undisturbed samples taken in this manner may be more useful than those taken from a cased hole, since the disturbance caused by advancing the auger is much less than that caused by driving the casing. Augers of this type are available with hollow stems having inside diameters from 2-3/4 to 6 inches.

FIGURE 1
AUGER FLIGHTS



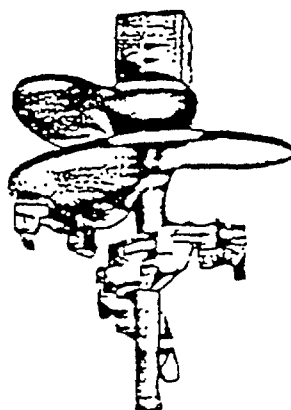
(a)

Single-Flight Earth Auger



(b)

Double-Flight Earth-Rock Auger



(c)

Double-Flight Rock Auger

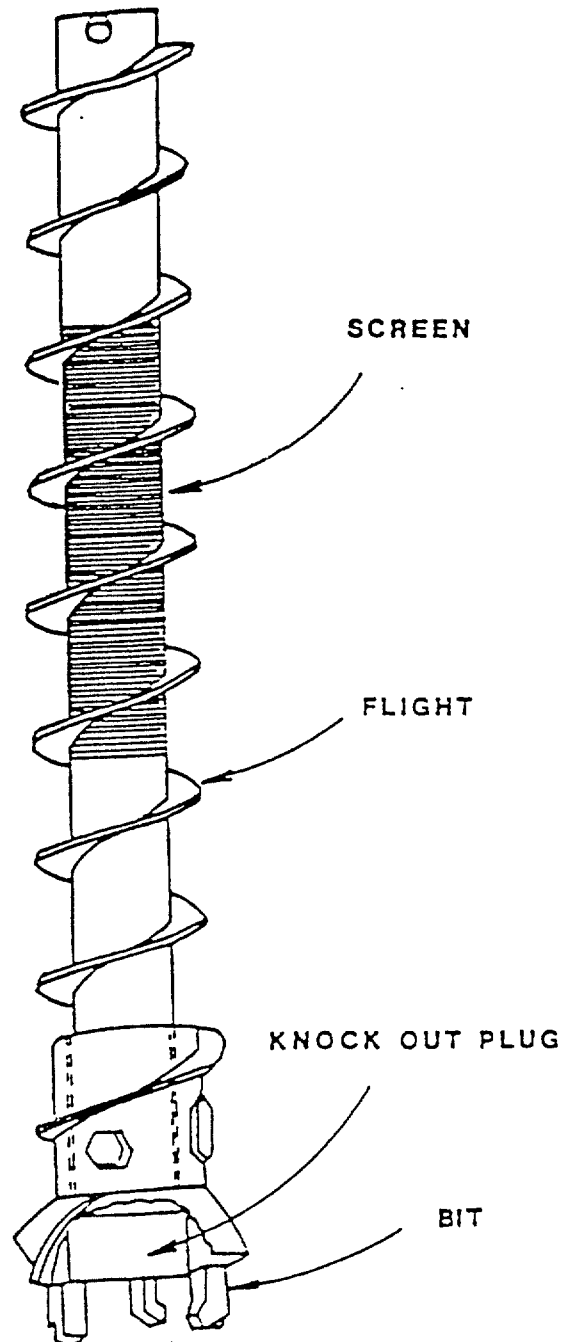


(d)

High-Spiral Auger

Source: U.S. EPA. 540/P-87/001. A Compendium of Superfund Field Operations Methods.

FIGURE 2
HOLLOW-STEM AUGER



Source: U.S. EPA, 540/P-87/001, A Compendium of Superfund Field Operations Methods.

The use of hollow-stem augers is advantageous, because drilling fluids that need to be controlled and limited when advancing a borehole are used only under special circumstances. The augers also allow direct access for soil sampling through the hollow inner part of the auger stem. The depths to which hollow-stem augers can bore are limited by the geologic formation and depth to groundwater. Hollow-stem augers are used primarily in formations that do not cave or have large boulders.

Upon reaching the desired depth, a small-diameter casing and screen can be set inside the hollow stem to produce a monitoring well. The augers are removed by section while the well screen and risers are held in place. Typically, one five-foot section of auger is removed at a time. In incompetent formations, the borehole surrounding the screen may be allowed to cave around the screen, or a clean sand or gravel pack may be installed as the augers are withdrawn. Once the screen is properly covered (usually to 2 feet above the top of the screen), a clay (bentonite) seal is installed. As a final step, grout or other impermeable material is tremied in place on top of the clay seal to ground level as the remaining auger sections are removed. Careful installation of clay and/or grout seals is essential, especially in areas where multiple aquifers are encountered.

Allowing the formation to collapse around the well may damage the screen and/or risers. Depending on formation material, sand or gravel pack may provide a better performing well.

2.2 Solid-Stem Augers

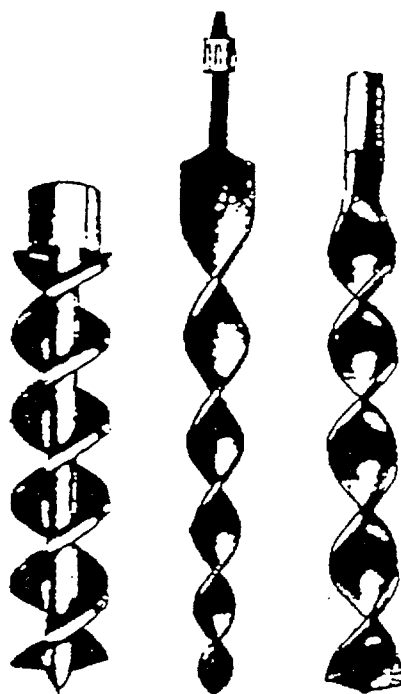
Solid-stem augers (Figure 3) are a type of powered auger that is advanced into the ground by the rotation and downward pressure of a rotary drill rig. These augers have interchangeable heads or bits for use in various types of soil.

As the solid-stem auger is advanced into the ground, new auger sections are added. Auger borings may be advanced to a depth of about 100 feet, depending on the soil conditions encountered. Casing may be used to prevent caving in of unstable soil, especially below the water table, when the auger is removed for sampling or placement of a monitoring well. The soil displaced by the auger is transported to the surface by the auger blade. This soil shows the general type of material through which the auger is passing, but definite determinations cannot be made about the depth from which the soil was excavated or about the soil structure.

Solid-stem augers are most efficient in advancing a boring in moist, cohesionless soils with some apparent cohesion and in medium-soft to stiff cohesive soils. These augers are not well suited for use in very hard or cemented soils, very soft soils, or saturated cohesionless soils.

Borings advanced with solid-stem augers are not useful when it is necessary to obtain undisturbed samples of soil material or to determine the location of soil contacts. Under certain conditions, solid-stem auger borings are useful in providing holes for monitoring well installation. It should be noted that it is almost impossible to drill through a contaminated soil zone with a solid-stem continuous-flight auger without downward transport of contaminants.

FIGURE 3
SOLID-STEM AUGER



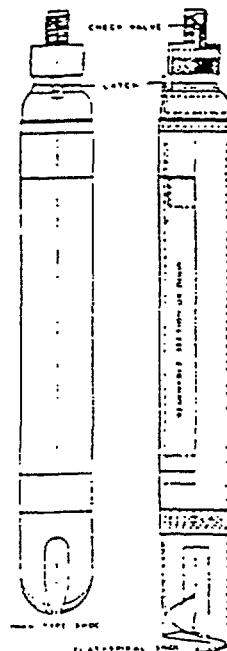
Large Helical or Worm-Type Augers



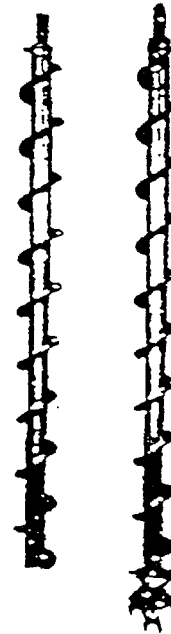
Spoon Auger



Vicksburg Hinged Auger



Spraue & Henwood
Barrel Augers



Buda Continuous
Helical Augers

Source: U.S. EPA. 540/P-87/001. A Compendium of Superfund Field Operations Methods.

2.3 Bucket Augers

The bucket auger is a type of powered auger that consists of a cylindrical bucket 10 inches to 72 inches in diameter with teeth arranged at the bottom. The bucket is fastened to the end of a drill bar that is rotated and pushed downward. The bucket is then filled, brought to the surface, and emptied by tipping it over. Bucket holes more than 3 feet in diameter may be drilled using a special attachment. With some types of cable tool drilling equipment, it may be difficult to reach some sites that are steep or marshy.

3.0 MUD AND WATER ROTARY DRILLING

In rotary drilling, the borehole is advanced by rapid rotation of the drilling bit, which cuts, chips, and grinds the material at the bottom of the hole into small particles. The cuttings are removed by pumping water or drilling fluid from a sump down through the drill rods and bit and up the annulus between the borehole wall and the drill rods. This water flows first into a settling pit and ultimately back to the main pit for recirculation. Water alone may be used when the depth is small and the soil is stable. Drilling mud is sometimes preferred, since the required flow is smaller and the mud serves to stabilize the hole; however, the mud may clog permeable soil units. A sample should be collected of any material introduced into the well (water, drilling mud, additives, etc.). The sample should be retained for future analysis if any questions of contamination arises. A section of casing is used to start the hole, but the remaining part of exploratory boreholes advanced by rotary drilling is usually uncased except in soft soils.

When rotary drilling is used for exploratory borings, items such as motors, rotary driving mechanisms, winches, and pumps, are generally assembled as a unit, with a folding mast mounted on a truck or tractor. The unit may also be mounted on intermediate skids so that it can be placed on a raft or moved into places inaccessible to motor vehicles.

Many types of rotary drilling bits are used, depending on the character of the material to be penetrated. Fishtail bits and two-bladed bits are used in relatively soft soils and three- to four-bladed bits in firmer soils and soft rock. The cutting edges are surfaces with tungsten carbide alloys or are formed by special hard-metal inserts. The bits used in rock have several rollers with hard-surfaces teeth. The two-cone bits are used in soft or broken formations, but the tri-cone and roller bits provide smoother operation and are more efficient in harder rocks. The number of rollers and the number and shape of the teeth are varied in accordance with the character of the rock. Relatively few and large teeth are used in soft rock, and the teeth are interfitting so that the bit will be self-cleaning. The teeth in all bits are flushed by drilling fluid flowing out of vents in the base of the bit. Boreholes produced by rotary drilling may be cased to provide stability. The drill rod and bit can be removed from the borehole, and a sampler can be lowered through the casing to remove soil from the bottom of the boring. Uncased boreholes are often filled with water to stabilize the hole and to remove material ground up by the boring tools. Water will exert a stabilizing effect on the parts of the hole that extend below groundwater level; however, above the water table, the water may result in a loss of soil strength and a collapse of the

hole. Water alone generally prevents neither caving of borings in soft or cohesionless soils nor a gradual squeezing-in of a borehole in plastic soils. Uncased boreholes filled with water are generally used in rock and are often used in stiff, cohesive soils.

An uncased borehole can often be stabilized by filling it with a properly proportioned drilling fluid or "mud", which, when circulated, also serves to remove ground-up material from the bottom of the hole. A satisfactory drilling fluid can occasionally be obtained by mixing locally available fat clays with water, but it is usually advantageous and often necessary to add commercially prepared drilling mud additives. When suitable native clays are not available, the drilling fluid is prepared with commercial products alone. These mud-forming products consist of a highly colloidal, gel-forming, thixotropic clays--primarily bentonite--with various chemicals added to control dispersion, thixotropy, viscosity, and gel strength. A sample of the drilling fluid should be analyzed to eliminate the possibility of introducing contamination into the borehole.

The stabilizing effect of the drilling fluid is caused in part by its higher specific gravity (in comparison with water alone) and in part by the formation of a relatively impervious lining or "mudcake" on the side walls of the borehole. This lining prevents sloughing of cohesionless soils and decreases the rate of swelling of cohesive materials. The drilling fluid also facilitates removal of cuttings from the hole. The required velocities and volume of circulation are smaller than for water alone, and the problem of uncontrolled erosion at the bottom of the hole is decreased. Furthermore, the drilling fluid is thixotropic; that is, it stiffens and forms a gel when agitation is stopped, and it can be liquified again by resuming the agitation. Drilling mud is, therefore, better able than water to keep the cuttings in suspension during the time required for withdrawal and reinsertion of boring and sampling tools. It also reduces abrasion and retards corrosion of these tools.

Rotary drilling is best suited for borings with a diameter of not less than 4 inches; a diameter of 6 to 8 inches is generally preferred when the method is used for exploratory boring. In most soils and rocks, the rate of progress is greater than that of other methods. However, rotary drilling is not well suited for use in deposits containing very coarse gravel, numerous stones and boulders, or chert nodules; in badly fissured or cavernous rock; or in very porous deposits with a strong groundwater flow, since an excessive amount of drilling fluid may be lost by seepage in such formations. Judicious selection of drilling mud additives and lost circulation material can ameliorate fluid loss problems. This method has a rapid drilling rate and generally can avoid placement of a casing by creating a mud lining on the wall of the well.

Major disadvantages of rotary drilling are as follows: (1) if not properly used, drilling fluids may introduce potential contaminants into the borehole; (2) a large amount of water needs to be controlled after use; and (3) the problem of lost circulation exists in highly permeable or cavernous geologic formations. The "filter cake" produced when drilling mud is used may reduce the permeability in water-bearing zones. Proper completion and well development can significantly lessen the adverse effect of filter cake and mud invasion into a formation.

When using the rotary drilling method for the installation of monitoring wells, care must be exercised to prevent recirculation of potentially contaminated drilling fluids into uncontaminated formations. In addition, during well development, drilling fluids must be thoroughly flushed from the borehole and the invaded zone to ascertain that samples collected are representative of true formation fluids.

4.0 AIR ROTARY METHODS

Air rotary rigs operate in the same manner as mud rotary drills, except the air is circulated down the drill pipe and returns with the cuttings up the annulus. A variation of the air rotary method is the air hammer method, which uses a pneumatic or percussion hammer that pulverizes rock and uses air to return cuttings to the surface.

Air rotary rigs operate best in hard rock formations. Formation water is blown out of the hole along with the cuttings, so it is possible to determine when the first water-bearing zone is encountered. After filtering water blown from the hole, collection and field analysis may provide preliminary information regarding changes in water quality for some parameters. Where significant water inflow is encountered, foaming agents may be added to enhance the ability of the air stream to remove cuttings from the wellbore. Formation sampling ranges from excellent in hard, dry formations to nonexistent when circulation is lost in cavernous limestones and other formations with cavities.

Casing is required to keep the borehole open when drilling in soft, caving formations below the water table. When more than one water-bearing zone is encountered and where the hydrostatic pressures are different, flow between zones will occur between the time the drilling is done and the time the hole can be properly cased and one zone grouted off. Multiple casing strings can be used to rectify this problem, if necessary. Synthetic drilling aids are not usually used in air rotary drilling. If the air is filtered to capture compressor lubricants, contamination can be minimized more effectively than with other methods. In badly contaminated subsurface situations, air rotary drilling must be used carefully to minimize the exposure of drilling personnel to potentially hazardous materials.

Air rotary methods are conducive to drilling in hard rock and other consolidated formations where a mud or water lining is unnecessary to support the walls against caving. An important advantage of using the air rotary method is that contamination of the water zone is not a factor since no drilling fluid is used.

5.0 DRIVE AND WASH METHODS

The drive-and-wash method is similar to cable tool drilling. In this method of drilling, the casing is driven by a weight or hammer into the unconsolidated materials. Soil entering the casing is washed out by circulating drilling fluid (water), and the casing is advanced again. A water rotary wash may also be used to clean the inside of the casing.

Drive and wash is limited to unconsolidated materials. The casing also acts as a temporary seal to prevent cross-contamination of aquifers. Although faster than cable tool drilling, drive and wash is not a very rapid method. If the wash water is not recycled, large quantities of fluids may require collection and disposal.

6.0 ROCK CORING

Rock coring techniques are used to obtain a continuous sample of rock at the project site for field logging and to provide samples of intact rock for laboratory testing. Additional information about the rock mass is available by careful observation of rig performance during drilling, drilling rate, bit wear, and loss of drilling fluid.

Prior to commencing the field explorations, the site geologist should specify the following items:

- Locations of rock-coring explorations
- Depth of rock-core penetration
- Length of core-run (usually 5 ft.)
- Specific rock-coring procedures

The site geologist should identify the locations of rock-core explorations with survey stakes and flagging. Locations of the explorations should be approximately determined by the Field Geologist using pocket-transit and pace method and should be plotted on the site base map.

The site geologist should indicate the information to be recorded during the rock-coring operation. The recorded information should include but not necessarily be limited to the following:

- Drill rate (minutes per foot)
- Type and size of bit
- Core number
- Depth range
- Core recovery (inches)
- Rock Quality Designation (RQD in percent; for NX-size core only)

The rock core should be classified by the site geologist using a rock classification system established for the program. There is no universal core barrel or drilling equipment for rock coring. The geologic and topographic conditions as well as the requirements of the project will dictate the type of equipment to be employed.

The following factors can result in good core production and should be observed during rock coring.

- Prepare a level and stable drilling platform before commencing the boring.
- Keep the drill stem as nearly vertical as possible. On deep core holes, true alignment of the casing is critical. The driller may elect to use a heavy drilling mud instead of casing to support the bore hole walls; this procedure is not as desirable under some conditions, but acceptable if satisfactory information is obtained.
- Wash the casing out thoroughly before inserting the core barrel.

- Inspect the selected core barrel and bit for wear, general cleanliness, and free movement of all parts. Reject any barrel or bit that appears unsatisfactory.
- Pump recirculated drill fluid down the drill rods and observe a return flow before commencing drilling operations.
- Carefully measure all lengths of rod, core barrel, and stick-up through all phases of drilling for accurate depth determination.
- Drill with minimal vertical pressure and rotation. Most rigs are equipped with a selection of gear ratios and a variable hydraulically-controlled feed mechanism. Driller expertise in selecting the correct combination of speed and feed rate is invaluable.
- Water return should be no more than just sufficient to bring the bore hole cuttings to the surface.
- Place the core carefully in the core box from left to right, top to bottom.
- If 100 percent recovery was not obtained, the bore hole should be sounded to determine if the missing core still remains in the bottom of the borehole.

7.0 DRILLING HOLE LOCATIONS

The locations for drilling holes, should include the following:

- Select desired hole location(s) and plot on design package parcel map.
- If possible, visit the site with the driller, and check it for acceptability, such as
- Land owner access - if not previously acquired by Client and main accessibility.
- Is the site adequate for a drilling operation (contractors decision) i.e., water supply, space, absence of overhead utilities.
- Check for physical evidence of underground utilities such as gas or waterlines, sewers, telephone or electrical cables.
- Even if no physical evidence of underground utilities is observed, all appropriate companies must be contacted to ensure that none actually exist.
- If site is not suitable, relocate to a acceptable location, preferably one which will not require obtaining another permit. Check to insure that the new location will fulfill the original intent for the exploration.

- Stake all holes with a clearly visible marker (i.e., florescent orange lath, flagging, etc.) labeled with the proper drill hole number.
- Check that all holes are properly located and labeled both on the topographic map and in field.

HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM
STANDARD OPERATING PROCEDURE 9
SUBSURFACE-SOIL SAMPLING

1. OBJECTIVE

The objective of this procedure is to define the requirements for the collection of soil (unconsolidated zone) samples with hand augers, Shelby tubes, or split-spoon samplers.

2. BACKGROUND

For the purpose of this procedure, subsurface soil samples are considered to be those collected below a depth of 1 ft using a split-spoon or Shelby-tube soil sampler. Samples collected from the surface to a depth of 1 ft are addressed in Hazardous Waste Remedial Actions Program (HAZWRAP) Standard Operating Procedure (SOP) 8, "Surface Soil Sampling."

Shallow soil samples (to depths of 10 ft) may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those collected by split-spoon or Shelby-tube samplers. Hand-augered samples should not be used for projects requiring Data Quality Objective (DQO) Level C or D quality assurance/quality control.

Split-spoon and Shelby-tube samplers are driven into undisturbed soil by percussion or hydraulically pushed through hollow-stem augers. Split-spoon and Shelby-tube samplers collect the sample in an enclosed tube, which prevents mixing and contamination by soils uphole. For DQO Level C or D sampling requirements for volatile organic compound (VOC) analysis, liners must be used.

3. RESPONSIBILITIES

Site Manager: The Site Manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that subsurface soil samples are collected in accordance with this procedure.

Project Field Geologist: The Project Field Geologist is responsible for complying with this procedure.

4. REQUIRED EQUIPMENT

4.1 GENERAL

- Site-specific sampling plan.
- Field logbook.
- Indelible black-ink pens and markers.
- Sample tags/labels and appropriate forms/documentation.
- Appropriate sample containers.
- Insulated cooler(s).
- Latex gloves.
- Plastic zip-top bags and waterproof sealing tape.
- Rinse bottles and deionized or distilled water.
- Decontamination equipment and supplies.
- Personnel protective equipment as required by the site-specific health and safety plan.
- Plastic sheeting.
- Chain-of-custody and security seals.
- Appropriate equipment and meters for obtaining field measurements specified in the site-specific sampling plan.

4.2 MANUAL (HAND) AUGERING

- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific work plan.
- Extension rods, as needed.
- Wrench(es), plier(s).

4.3 SPLIT-SPOON AND SHELBY-TUBE SAMPLING

- Drill rig equipped with a 140-lb drop hammer and sufficient hollow-stem augers to drill to the depths required by the site-specific work plan.
- Sufficient numbers of split-spoon or Shelby-tube samplers so that at least one is always decontaminated and available for sampling. Three split-spoon or Shelby-tube samplers are generally the minimum necessary. (Shelby tubes are usually used only once.)
- Teflon split-spoon or Shelby tube liners, as appropriate.
- Sample containers, labels or tags, and required chain-of-custody forms.
- Sufficient plastic sheeting to contain all cuttings and cover the ground surface under the rig.

- Decontamination supplies.
- Personnel protective equipment as required by the site-specific health and safety plan.

5. PROCEDURES

5.1. MANUAL (HAND) AUGERING

The following steps must be followed when collecting hand-augered samples:

1. Survey and stake the location(s) to be sampled. The survey should include horizontal location and elevation relative to mean sea level or other specified data. Horizontal and vertical measurements by surveying may occur before or after the sampling event, if applicable.
2. Clear vegetation and other debris from the surface around the boring location.
3. Put on personnel protective clothing and equipment as required by the site-specific health and safety plan.
4. Prepare an area next to the sample collection location by laying plastic sheeting on the ground or over the work area.
5. Set up the decontamination line.
6. Begin augering to the depth required for sampling. Place cuttings as specified in the Field Sampling and Analysis Plan (FSAP) or Quality Assurance Project Plan (QAPP). If possible, lay out cuttings in stratigraphic order.
7. While augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.
8. Stop drilling at the top of the specified or selected sampling depth. Remove the auger from the hole and decontaminate according to HAZWRAP SOP 14. Then either use a fresh auger or the decontaminated original auger to obtain a sample.
9. Place the sample in the appropriate container, label it, and store it in a cooler. Note the sample identification number, depth from which sample was taken, and analyses requested in the field logbook and on the appropriate forms.
10. Proceed with further sampling, as required by the site-specific FSAP or QAPP.
11. When all sampling is completed, dispose of cuttings as specified in the FSAP or QAPP.
12. Decontaminate all equipment according to HAZWRAP SOP 14.
13. Remove plastic sheeting and place in the designated receptacle.
14. Complete the field logbook entry and soil boring log per HAZWRAP SOP 1, Parts A and B, respectively, for the site. Remand custody of samples to the appropriate personnel.

(Note: The above is a DQO Level B sampling methodology for VOCs and Level C and D for all other analytes.)

5.2 MANUAL (HAND) AUGERING USING A TUBE SAMPLER WITH LINER

The following steps must be followed when hand-augering with a tube sampler with liner:

1. Survey and stake the location(s) to be sampled. The survey should include horizontal location and elevation relative to mean sea level or other specified datum. Horizontal and vertical measurements by surveying may occur before or after the sampling event, if applicable.
2. Clear vegetation and other debris from the surface around the boring location.
3. Put on personnel protective clothing and equipment as required by the site-specific health and safety plan.
4. Prepare an area next to the sampling collection location by laying plastic sheeting on the ground or over the work areas.
5. Set up the decontamination line.
6. Begin augering to the depth required for sampling. Place cuttings as specified in the FSAP or QAPP. If possible, lay out cuttings in stratigraphic order.
7. While augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.
8. Stop drilling at the top of the specified or selected sampling depth. Remove the auger from the hole and decontaminate according to HAZWRAP SOP 14.
9. Prepare a decontaminated tube sampler by installing a decontaminated Teflon liner in the tube.
10. Obtain the sample and retrieve it. Remove the liner and sample from the tube and cap and seal the ends with waterproof tape.
11. Label the sealed liners as required. Mark the top and bottom of the liner. Place the sample in the designated cooler. Note the sample identification number, depth from which the sample was taken, and analyses requested in the field logbook and on the appropriate forms.
12. Proceed with further sampling, as required by the site-specific FSAP or QAPP.
13. When all sampling is completed, dispose of cuttings as specified in the FSAP or QAPP.
14. Decontaminate all equipment according to HAZWRAP SOP 14.
15. Remove plastic sheeting and place in the designated receptacle.
16. Complete the field logbook entry and boring log per HAZWRAP SOP 1, Parts A and B, respectively, for the site. Remand custody of samples to the appropriate personnel.

(Note: The above procedure represents DQO Level C and D methodologies for all analytes.)

5.3 SPLIT-SPOON SAMPLING

The following steps must be followed when collecting samples with the split spoon:

1. Survey and stake the location(s) to be sampled. The survey should include horizontal location and elevation relative to mean sea level or other specified data.
2. Clear vegetation and debris from the ground surface. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
3. Prepare the site by laying plastic sheeting around the hole site and over the ground on which truck(s) will be parked.
4. Set up the decontamination line for split spoons and other small sampling equipment. The drilling rig will be decontaminated according to HAZWRAP SOP 14 at a separate location.
5. Attach the hollow-stem auger with the cutting head and center rod(s).
6. Put on personnel protective clothing and equipment as required by the site-specific health and safety plan.
7. Begin drilling and proceed to the first sample depth.
8. Slightly raise the auger flight(s) to disengage the cutting head and rotate without advancement to clean cuttings from the bottom of the hole.
9. Remove the plug and center rods.
10. Install a decontaminated split spoon on the center rod(s) and insert into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
11. Mark the center rod in 6-in. increments from the top of the auger flight(s).
12. Drive the spoon using the hammer. Use a full 30-in. drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the spoon or tube through each 6-in. increment.
13. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little (<1 in.) or no progress is made for 50 blows of the hammer.
14. Pull the spoon or tube free by using upswings of the hammer to loosen the sampler. Pull out the center rod and spoon or tube.
15. Unscrew the split-spoon assembly from the center rod and place it on the sampling table.
16. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.
17. With the drive shoe and head assembly off, split the spoons, being careful not to disturb the sample.
18. Describe the sample in detail in the field logbook and on the boring log form per HAZWRAP SOP 1, Parts A and B, respectively, then remove enough soil to fill the required sample containers. Seal, label, and store samples as required by the site-specific work plan. (Note: if volatile organic analyses are to be conducted on the

- soil sample, place the sample in the sample container first, then describe it in the field logbook and on the boring log form.)
19. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
 20. When sampling is complete, remove the drilling rig to the heavy equipment decontamination site.
 21. Dispose of cuttings as specified in the FSAP or QAPP.
 22. Decontaminate split spoons and other small sampling equipment according to HAZWRAP SOP 14.
 23. Remove plastic sheeting. Place plastic and other disposables in the appropriate receptacles.
 24. Note all relevant information in the field logbook before leaving the site.

5.4 SPLIT-SPOON SAMPLING USING LINERS

The following steps must be followed when collecting samples with the split spoon with lines:

1. Survey and stake the location(s) to be sampled. The survey should include horizontal location and elevation relative to mean sea level or other specified data.
2. Clear vegetation and debris from the ground surface. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
3. Prepare the site by laying plastic sheeting around the hole site and over the ground on which truck(s) will be parked.
4. Set up the decontamination line for split spoons and other small sampling equipment. The drilling rig will be decontaminated according to HAZWRAP SOP 14 at a separate location.
5. Attach the hollow-stem auger with the cutting head and center rod(s).
6. Put on personnel protective clothing and equipment as required by the site-specific health and safety plan.
7. Begin drilling and proceed to the first sample depth.
8. Slightly raise the auger flight(s) to disengage the cutting head and rotate without advancement to clean the bottom of the hole of cuttings.
9. Remove the plug and center rods.
10. Install a decontaminated Teflon or stainless steel liner in the split-spoon barrel.
11. Install a decontaminated split spoon on the center rod(s) and insert into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
12. Mark the center rod in 6-in. increments from the top of the auger flight(s).
13. Drive the spoon using the hammer. Use a full 30-in. drop as specified by ASTM Method D-1586. Record the number of blows required to drive the spoon or tube through each 6-in. increment.

14. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little (<1 in.) or no progress is made after 50 blows of the hammer.
15. Pull the spoon or tube free by using upswings of the hammer to loosen the sampler. Pull out center rod and spoon or tube.
16. Unscrew the split-spoon assembly from the center rod and place it on the sampling table.
17. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.
18. With the drive shoe and head assembly off, split the spoons and remove the liners without disturbing the sample. For a normal 2-in.-O.D. split spoon, four 6-in. liners were installed.
19. Immediately install a Teflon septa over the ends of the liners and cap and seal the ends of the liner with waterproof tape. Label and store samples as required by the site-specific work plan. Mark the top and bottom of the sample on the outside of the liner.
20. Describe sample lithology from cuttings and from observation of the bottom end of the sample in the liner.
21. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
22. When sampling is complete, remove the drilling rig to the heavy equipment decontamination site.
23. Dispose of cuttings as specified in the FSAP or QAPP.
24. Decontaminate split spoons and other small sampling equipment according to HAZWRAP SOP 14.
25. Remove plastic sheeting. Place plastic and other disposables in the appropriate receptacles.
26. Note all relevant information in the field logbook before leaving the site.
(Note: The above represents DQO Level C and D sampling methodologies for all analytes.)

5.5. SHELBY-TUBE SAMPLING

The following steps must be followed when collecting samples with the Shelby tube:

1. Survey and stake the location(s) to be sampled. The survey should include horizontal location and elevation relative to mean sea level or other specified datum.
2. Clear vegetation and debris from the ground surface. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
3. Prepare the site by laying plastic sheeting around the hole.

4. Set up the decontamination line for split spoons and other small sampling equipment. The drilling rig will be decontaminated according to HAZWRAP SOP 14 at a separate location.
5. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).
6. Put on personnel protective clothing and equipment as required by the site-specific health and safety plan.
7. Begin drilling and proceed to the first sample depth.
8. Slightly raise the auger flight(s) to disengage the cutting head and rotate without advancement to clean the bottom of the hole of cuttings.
9. Remove the plug and center rods.
10. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby-tube assembly to the center rods.
11. Lower the Shelby tube and center rods into the hollow-stem augers until seated at bottom. Be sure to leave 30 in. or more of center rod above the lowest point of the hydraulic piston's extension.
12. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube should be pushed with a steady force.
13. When the Shelby tube has been advanced its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, twist to break off the sample, and pull it out of the hole with the rig winch.
14. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.
15. Use a hydraulic extruder to extrude the sample from the tube onto a clean piece of plastic sheeting.
16. Describe the sample in detail in the field logbook and on the boring log per HAZWRAP SOP 1, Parts A and B, respectively, then remove enough soil to fill the required sample containers. Seal, label, and store samples as required by the site-specific work plan. (Note: if volatile organic analyses are to be conducted on the soil sample, place the sample in the sample container first, then describe it in the field logbook and on the boring log form.) However, this method of sampling for volatile organic analytes in subsurface soils can only be considered a screening data quality level.
17. If the intent of the Shelby-tube sampling is for engineering purposes and an undisturbed sample is required, the ends should be sealed immediately, the top or "up" end of the tube marked, and the tube should be transported to the laboratory in an upright position.
18. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
19. When sampling is complete, remove the drilling rig to the heavy equipment decontamination site.
20. Dispose of cuttings as specified in the FSAP and QAPP.
21. Decontaminate Shelby tubes and other small sampling equipment according to HAZWRAP SOP 14.

22. Remove plastic sheeting. Place plastic and other disposables in the appropriate receptacles.
23. Note all relevant information in the field logbook before leaving the site.
(Note: This sampling procedure satisfies sampling requirements for DQO Level A or B methodologies for VOCs.)

6. RESTRICTIONS/LIMITATIONS

Basket or spring retainers may be needed for split-spoon sampling in loose, sandy soils.

Shelby tubes may not retain the sample in loose, sandy soils.

7. REFERENCES

- American Society for Testing and Materials, *Penetration Test and Split Barrel Sampling of Soils*, Standard Method D-1586-84, 1984.
- U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, 1987.

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SOP-FL-008 MONITORING WELL INSTALLATION

1.0 INTRODUCTION

This SOP discusses the aspects of installing monitoring wells. It provides the reader with the methodology for siting monitoring well locations for the standard operating procedures (SAP). It provides procedures for well design and well construction to aid in the development of drilling subcontracts. Drilling operation and well development guidelines are presented to aid the reader in the oversight of the installation of monitoring wells. Additionally, slug test procedures have been outlined in SOP-FL-004 to perform insitu permeability tests on a monitoring well.

The principal reason that monitoring wells are constructed is to collect groundwater samples that, upon analysis, can be used to delineate a contaminant plume and track movement of specific chemical or biological constituents. A secondary consideration is the determination of the physical characteristics of the groundwater flow system to establish flow direction, transmissivity, quantity, etc. The spatial and vertical locations of monitoring wells are important. Of equal importance are the design and construction of monitoring wells that will provide easily obtainable samples and yield reliable, defensible, meaningful information. In general, monitoring well design and construction follows production well design and construction techniques. However, emphasis is placed on the effect these practices may have on the chemistry of the water samples being collected rather than on maximizing well efficiency.

From this emphasis, it follows that an understanding of the chemistry of the suspected pollutants and of the geologic setting in which the monitoring wells are constructed plays a major role in determining the drilling technique and materials used.

2.0 WELL SITING

The following procedures should be followed:

- Review and familiarize oneself with pertinent proposal sections and specifications. Review and familiarize oneself with subcontractors contracts. Review and familiarize oneself with any regulations governing how, where or when the well is drilled. Review and familiarize oneself with data (supplied by the Client, or any other data available) used for program planning.
- Identify well site on a topo map or other suitable project base map. Contact landowner at the beginning of well siting. Inquire whether the proposed drill locations will interfere with the landowner's established land use. Unless the property is wholly owned by the client, then the landowner is always contacted before entering the property, even if he is leasing back the property from the client.

- Check route to insure a drill rig can access the proposed well site. Plan routes which require the least disturbance of natural vegetation or natural countryside conditions and which would not require grading or other types of work by i.e., backhoes, etc.
- The well site should be reasonably level and absent of large boulders or other hazardous obstructions.
- Check to insure absence of buried high pressure gas, or oil or water lines. If any lines are present relocate the well site a safe distance away from them. Be sure to check with the driller to insure his agreement.
- Check to insure absence of overhead power transmission lines. If any overhead power lines are present, relocate the well site a safe distance away from them. Be sure to check with the driller to insure his agreement.
- If practical, make arrangements to have any necessary earthen mud pits excavated prior to setting the rig over the well location. This needs some input by the driller and greatly reduces (in some cases) set up and starting time.
- Stake the well location with a 1/4" x 1" lath marked with the well number and, if known, or if necessary, the total depth (T.D.).
- Pre-drilling (on-site) meeting with drilling and logging contractors. Brief the contractors on access routes to well site locations, numbering sequence, any potential access problems and general T.D. estimates. Establish a chain of command and responsibility for personnel involved. Review project objectives and procedures with contractors.
- Consult landowner about water source and access, then notify the driller of these decisions.
- Explain to the driller the need for care and accurate retrieval of drill cuttings and, if necessary, placement and accounting of materials during well completion. Explain to the geophysical truck operator any specific needs you have or results you require from his equipment such as an expanded natural gamma scale or reduced sensitivity on the spontaneous potential (S.P.) log, etc.

3.0 WELL DESIGN

The following procedures should be followed:

- Examine the geophysical log and determine the exact interval(s) and depth(s) of the completion zone(s). Calculate the quantity of slotted casing or screen, blank casing, sealing materials, gravel pack and cement necessary to complete the well.
- Use a cementing company handbook (e.g., Halliburton or Dowell) to calculate the quantities of gravel pack, sealing materials and cement. If one of these is not available then figuring the volume of the bore hole ($r_b^2 \times L$) minus the volume of the casing ($r_c^2 \times L$) will yield volume per linear foot.

A cubic foot of silica sand weighs 100 pounds. Frequently silica sand is packaged in 100 pound sacks but should be purchased and delivered in bulk quantities. A five gallon bucket is equal to 0.67 cubic feet. Dividing the determined or calculated volume between the well bore and the outside of the casing(s) into 0.67 cubic feet per bucket will yield approximately the number of feet per bucket of silica sand. Dividing the total interval of the intended gravel pack by the number of feet per bucket of gravel pack will yield approximately how many buckets of gravel will be required. This same method can be used if the silica sand arrives in 1-cubic foot sacks (100 lbs) except the final value is approximately the number of feet per sack of silica sand.

Cement usually comes in 94 pound sacks and can be mixed in the field to obtain volumes between 0.88 cubic feet per sack to 1.50 cubic foot per sack. See the table on the next page for the most common cement slurry mixtures.

The calculation to determine the amount of cement needed for seals, caps or plugs is governed by the volume of mixture per sack desired. This volume should be specified either in the project proposal or the drillers' contract. If there is any doubt, then consult the hydrogeologist in charge. Determine the amount of cement in the same manner as the silica sand calculation for the gravel pack.

Clay seals are routinely placed in a well completion above the gravel or filter pack and below the cement or grout cap or plug. The clay seals are generally a bentonite clay and before swelling (in the bore hole) has the form of 1/4" to 1/2" tablets. A common type of bentonite tablets are American Colloid Volclay Tablets. The tablets generally come in plastic containers of 20 and 50 pounds but can also arrive in boxes or cloth sacks.

Water-Cement Ratio (gals. water per sack)	Weight per Gallon of Slurry (lbs)	Volume of Mixture per sack (cu. ft.)
7 1/2	14.1	1.50
7	14.4	1.43
6 1/2	14.7	1.35
6	15.0	1.28
5 1/2	15.4	1.21
5	15.8	1.14
4 1/2	16.25	1.08
4	16.50	1.00
3 1/2	17.35	0.95
3	18.1	0.88

The volume of the bentonite tablets needed for a specific seal thickness can be calculated in the same manner as was done for the gravel pack and cement requirements.

These methods of estimating the quantity of materials to be used in any specific well completion are crude at best. There may exist portions of the bore hole that are of a larger diameter, due to erosion during drilling, or sections of a somewhat smaller diameter due to swelling conditions; the estimated quantities seem always to be either too little or too much.

Note: Rig stand-by time, while waiting on supplies, is paid at an hourly rate as is well completion. The more quickly the completion is done the lower the cost per foot for the well.

Measure all materials twice during the well construction. First, when estimating the quantity of supplies needed for the completion, second, during well construction. Keep the first estimate in the daily log book record the actual (second measurement) intervals (tops and bottoms), quantity and type of materials placed in the well recorded on the appropriate forms

4.0 WELL CONSTRUCTION

The following procedures should be followed:

4.1 Final Design of Casing - Screen/Slotted Casing String(s)

If there is any doubt about the final design of the casing string, based on data from the pilot hole or the individual drill holes scheduled for completion, verify the design with the hydrogeologist in charge.

It is the rig hydrogeologist's responsibility to insure adequate supplies are maintained at each well site even though it may be the contractors responsibility for supplying the materials.

4.2 Installing Casing (Slotted/Screen Casing String(s))

1) Plastic or Polyvinylchloride (PVC) Casing -

Join all 10 foot lengths of casing (blank and screen) by flush-joint threading. All pipe is to be cut with a pipe cutting tool which leaves a smooth, square end. Sawing is not permitted.

2) Steel Welded or Standard Threaded - Coupled (STC) Casing -

The steel welded casing-slotted/screen casing string(s) are joined at a smooth, flat joint and welded. Accomplish alignment using both a carpenters level (or other suitable level) and a casing-alignment clamp. If the steel casing is the threaded and coupled-type casing then alignment is insured by not cross-threading the couple and the pipe. Lubricate the joint with a suitable grease and tighten with pipe wrenches, chain tongs or power tongs until the string is screwed together tight enough to prevent unscrewing or shearing out of the threaded joint.

3) A complete casing-slotted/screen casing string tally is kept by both the hydrogeologist and the contractor. Seal the bottom on the casing-slotted/screen casing string with a cap, glued and screwed permanently in place.

4.3 Installing Filter Material (Gravel Pack)

1) Place the filter material downhole using a tremie pipe. The length of pipe should end no more than 20 feet above the bottom of the hole, or the bottom of the interval to receive the filter pack. Gradually lift removing sections of pipe, as the filter material being placed in the hole rises. Check the height of the filter material periodically with the tremie pipe.

2) Mix clean water with the filter material to facilitate its downward movement and to help prevent clogging up the tremie pipe.

3) Place the filter material continuously at a rate which prevents bridging either in the tremie pipe in the bore hole.

4) The filter material shall be installed to levels pre-determined by the hydrogeologist. The exact depth for each well is determined from the final well design. However, generally the top of the filter material will be 5 feet above the top of the highest slotted/screened interval.

5) Following placement of the filter material "sound" or "tag" this depth with the tremie pipe to insure it is at the prescribed level.

4.4 Installing Bentonite Pellet Seals (Blanket)

Following the installation of the filter material place a bentonite pellet blanket seal on top of the filter material to prevent contamination of the filter pack by the grout.

- 1) The actual amount of the annulus which is filled with bentonite pellets may vary from completion to completion but a minimum of 6 inches of the annulus should be filled with bentonite by gravity feed from the surface. The tremie pipe remains in the bore hold during gravity feed of the bentonite pellets. Calculate the exact volume of pellets needing placement.
- 2) Following placement of the bentonite pellets the depth is tagged with the tremie pipe to insure they are at the desired level. This is done carefully to prevent plugging of the tremie pipe.

4.5 Grouting

- 1) Grout the annular space above the bentonite pellets as directed by the hydrogeologist.
- 2) The grouted volume of annular space will vary from completion to completion, and sometimes within the same completion. Generally, if the annular space exceeds approximately 20 feet then the grouting is done in more than one stage. Take care to insure that the grout does not displace the bentonite seal or exceed (in weight) the collapse strength of the casing.
- 3) The methods of mixing grout in the field are numerous. The first concern is that the slurry mixture is fluid enough for placement by tremie pipe and heavy enough to give the desired strength and sealing properties required. Reference to the table from Halliburton Cementing Tables, 1979 or some other suitable source for the amount of water per sack, and then measure accurately into a large tub (water trough) or steel pit. Mix the correct number of bags of cement with the water at a rate which prevents, clotting or settling out of dry, unmixed cement. Usually this procedure is accomplished with a portable pump which sucks the water or cement mixture in and then expels it under pressure through a hose which is used in a jetting fashion at the opposite end of the tank, pit or trough.

Grout also can be mixed using a shovel or hoe. Generally, the grout is placed on the side of the tub, the bag is ruptured, and the cement is slowly added to the water. If the cement has hard spots place on a screen of approximately 1/4" mesh attached to some type of frame which is placed across the mixing tub. The cement is then "filtered" for the larger; hard pieces or blocks.

- 4) Add, near the end of the mixing stage, approximately 2 to 4 percent calcium chloride. The calcium chloride reduces the curing time for the grout. Less than 2 percent is of little use and in excess of 4 percent will not decrease the curing time beyond an optimum period. However, an excess (greater than 4 percent) will not harm the system either. Sometimes it is also desirable to mix approximately 2 percent Bentonite with the cement. This percentage of bentonite offsets shrinkage in the grout when it hardens.

5) Pumping or Pouring Grout

Place the mixed grout above the bentonite pellets. The time between placement of the bentonite pellets and the grout should not be less than 15 to 20 minutes. This allows the pellets to settle to the top of the gravel pack and to begin to swell, while not allowing the grout to harden.

- a) The grout can either be pumped down the tremie pipe by same pump used for jetting or it can be poured by buckets through a funnel into the tremie pipe. Displacement of the bore hole fluid is almost certain because the grout slurry weighs more than the residual borehole fluid (10 or 11 pounds per gallon for the mud versus 14 to 18 pounds per gallon for the grout).
- b) Except under rare circumstances, grout is never poured from the surface nor is it ever poured into standing water.
- c) Following pumping, or placement, of the grout seal, rinse the pipe with clear water and remove. Rinsing is accomplished by pouring clear water behind the grout prior to pulling the tremie.
- d) Grout the remainder of the hole by gravity feed from the surface as directed by the hydrogeologist. The quantity of grout placed from the surface should not exceed the collapse strength of the casing and should not be initiated prior to the curing of the grout seal above the bentonite pellets.
- e) The best documentation of well construction is to geophysically log the completed well using Density and Natural Gamma techniques. These curves will allow depth-verification of gravel pack, bentonite and grouted intervals in addition to the actual depth to the protective cap at the bottom of the casing-slotted/screen casing string. This technique is limited to materials other than steel casing strings and to budget constraints.

5.0 DRILLING OPERATIONS

5.1 Drilling

If the drill hole was initially drilled as a pilot hole or core hole then it may need reaming to a larger diameter to facilitate construction as a production/monitoring well. The diameter will depend on several factors and may vary from project to project. The ultimate responsibility for hole diameter is a combination of the needs of the hydrogeologist in charge and rig capabilities.

At the onset of reaming record starting time and date on the well construction form or diagram. Then continue documenting the logging and well completion.

5.2 Documentation

Documentation is imperative when drilling. Drilling data is recorded on the soil boring log form. Daily activities of the drill crew and supervisor are essential for keeping within cost guidelines and to identify potential completion problems. Record daily field activities in the field log book. (Problems encountered while drilling are usually charged at the hourly rig rate so that accurate records are necessary. Drilling is generally paid by the foot. Recording the time of start-up and completion as well as total hole depth is mandatory.)

Record rig activities during the drilling of the well. The following:

- 1) Start-up and shut-down time for the day and visitors at the site.
- 2) Problems encountered during the day (e.g. slow drilling, thunder storms, down time due to maintenance, waiting on water, injuries and important conversations, decisions made during the day, or any other item which slows or stops drilling).
- 3) Penetration rate and problems with swelling clays or caving sand or gravel.
- 4) Type of bit(s) and materials used (bentonite, foam, etc.) and quantity used during drilling (Identify zones where circulation was lost or where water production is observed (or increases) when drilling with air).
- 5) Sampling of drill cuttings is often performed by one of the drill crew. Ask the crew to collect cuttings samples approximately every five feet unless otherwise specified. Capture samples utilizing a screen-type strainer placed in the path of the discharging mud as it emanates from the borehole. When drilling with air injection, collect cuttings samples near the run of the deflector shield. (Do not wash samples extruded with air injection). Insure that the samples (when drilling with mud) are carefully washed, using clear water, prior to describing them. After description, label each bag completely and place in sequence (of increasing depth) in cuttings' boxes. Sample bags labels should have following minimum information:
 - The sample interval
 - Well number
 - Project name and number
 - Name of investigator
- 6) Additional data listed below is included on a separate form or forms, but should always be recorded and filed with the hole's drilling history:
 - Hole size
 - Type of drilling
 - Drilling fluid
 - Penetrating rate
 - Circulation losses or gains
 - Drill behavior
 - Drillers observations
 - Sampling intervals
 - Caving, swelling or squeezing intervals

- 7) Record lithologic character versus depth data as completely and as accurately as possible as the material changes. These descriptions typically include:
 - Rock type
 - Color
 - Mineralogy, including secondary mineralizations
- 8) Additional data in sedimentary rocks includes:
 - Sorting
 - Cementation
 - Density or compaction
 - Rounding
- 9) During logging relate materials to geologic origin, if possible, i.e., glacial till, stream terrace, buried channel, Fort Union Formation, etc., including:
 - Rock type
 - Color
 - Grain size
 - Mineralogy
 - Bedding thickness, dip and type (i.e., stylolitic or shale partings).
 - Natural joints and fractures including frequency, dip, second, any coatings or fillings. A graphical representation of these features may also be desirable.
- 10) Additional notes to be recorded include:

Log the core or cuttings as quickly as possible after removal from the hole. Some materials may degrade rapidly upon exposure, resulting in apparently poor rock, which was not actually present in the subsurface.

Check carefully, if logging core, each core end and try to determine if the fracture is natural or mechanical in origin. Mechanical fractures often can be identified by their orientation, the absence of secondary coatings or filling and slickensides, and its fit with the adjacent core piece. If doubt exists, consider it a natural fracture. If it is determined that the fracture is mechanical, ignore it and consider the two pieces of core as a single piece.

Wet samples are contained in sealable plastic bags. Double bag each sample putting the sample tag between the first and second bag.
- 11) Description of drill cuttings will contain at least the following parameters:
 - Rock type
 - Color
 - Grain size
 - Sorting
 - Cementation
 - Density or compaction

- Rounding
- Mineralogy
- The Total Depth (TD) of the drill hole should be determined and conveyed to the driller as early as possible - preferably before drilling begins. However, this is not always the case and every effort should be made to determine TD as soon as practicable.

5.2 Cleaning

Circulating to clean the drill hole out prior to removing the drill pipe is imperative. Once TD is determined and the depth is obtained, the driller should pull the drill up a short distance (1/4 - 2 feet) from the TD and continue to circulate with whatever fluid the hole was drilled with for a reasonable length of time. This action is to remove any drill cuttings which may have remained in suspension, or were in trans, at the time TD was obtained. Significant accumulation of drill cuttings may occur on the bottom of the drill hole if circulation is not accomplished. This can prevent logging the lower portion of a zone, which could be an important part of the well construction, or may be important for correlation purposes.

Use the sample screen to quickly check the amount of drill cuttings which are being removed during the circulation period. A small amount of cuttings are acceptable. Usually for shallow holes, 150-250 feet in depth, a circulation period of 10 to 15 minutes is adequate. This brief period of circulation insures that both the geophysical logging and completion of the hole as a production or monitoring well is consummated without delay. Circulation precludes delays caused by running the drill pipe back into the drill hole to remove sloughing or other fill at the bottom of the hole. Other problems may also occur, such as hanging the geophysical tool up or wedging in several hundred feet of well casing which can prove to be very costly in either retrieval attempts or redrilling of the hole.

SOP-FL-009
MONITORING WELL DEVELOPMENT

1.0 INTRODUCTION

All completed wells, whether the production or monitoring type, must be developed in order to facilitate unobstructed and continuous groundwater flow into the well. Well development is the process of cleaning the fines from the face of the borehole and the formation near the well screen. During any drilling process the side of the borehole becomes smeared with drilling mud, clays or other fines. This plugging action substantially reduces the permeability and retards the movement of water into the well screen. If these fines are not removed, especially in formations having low permeability, it then becomes difficult and time consuming to remove sufficient water from the well before obtaining a fresh groundwater sample because the water cannot flow easily into the well.

In the construction of high-capacity production type water wells, the development process is an important step to assure maximum hydraulic efficiency. Even though hydraulic efficiency is not a prime consideration in the construction of monitoring wells, nevertheless, development should be performed.

Development is required for the following reasons:

- To restore the natural permeability of the formation adjacent to the borehole to permit the water to flow easily into the screened zone
- To remove the clay, silt and other fines from the formation so that during subsequent sampling the water will not be turbid or contain suspended matter which can easily interfere with chemical analysis

The development process is best accomplished for monitoring wells by causing the natural formation water inside the well screen to move vigorously in and out through the screen in order to agitate the clay and silt, and move these fines into the screen. The use of water other than the natural formation water is not recommended.

2.0 PROCEDURES

- 1) Compressed air pumped down a pipe inside the well casing can be used to blow water out of the monitoring well. If air is applied to the well intermittently and for short periods then the water is only raised inside the casing rather than blown out and will fall back down the casing causing the desired back washing action. Also, blowing the water out will remove the fines brought into the screen by the agitating action.
- 2) Considerable care must be exercised to avoid injecting air into the well screen. Such air can become trapped in the formation outside the well screen and alter subsequent chemical analyses of water samples. For this reason, the bottom of the air pipe should never intercept the screen.

- 3) Another restriction on the use of air is the submergence factor. Submergence is the feet of water above the bottom of the air pipe while pumping (blowing water out) divided by the total length of the air pipe. Submergence should be on the order of at least 70 percent, which may be difficult to achieve with many shallow monitoring wells.

3.0 ALTERNATIVE METHODS

Alternative well development methods may be used including:

- **Surge Block** - A surge block is a round plunger with pliable edges such as belting that will not catch on the well screen. Moving the surge block forcefully up and down inside the well screen causes the water to surge in and out through the screen accomplishing the desired cleaning action. Surge blocks are commonly used with cable-tool drilling rigs, but are not easily used by other types of drilling rigs.
- **Bailer** - A bailer sufficiently heavy that it will sink rapidly through the water can be raised and lowered through the well screen. The resulting agitating action of the water is similar to that caused by a surge block. The bailer, however, has the added advantage of removing the fines each time it is brought to the surface and dumped. Bailers can be custom-made for small diameter wells, and can be hand-operated in shallow wells.
- **Surging and Pumping** - Starting and stopping a pump so that the water is alternately pulled into the well through the screen and backflushed through the screen is an effective development method. Periodically pumping to the surface will remove the fines from the well and permit checking the progress to assure that development is complete.

Well development should continue until the water becomes free of sediment or contains sediment in a lesser amount than was initially present. Conductivity, pH, temperature and turbidity (as measured by a turbidity meter) of the development water must all have stabilized prior to ceasing development. Disposal of development water is site specific and should be discussed in the Sampling and Analysis Plan or Work Plan.

SOP-FL-012 GROUNDWATER SAMPLING

1.0 INTRODUCTION

Low-flow purge and sampling is appropriate at locations where disturbance of the media around the well screen needs to be minimized. A common concern is turbidity in the monitoring wells and the consequent undesirable effects on metals sampling results.

2.0 LOW-FLOW PURGE AND SAMPLING

The low-flow purge and sample method creates less disturbance and agitation in the well, and therefore excess turbidity is not generated during the purging and sampling process. The result is a more rapid stabilization of turbidity and other parameters (pH, temperature, specific conductivity, dissolved oxygen, Eh), and a sample more representative of conditions in the formation is collected.

The low flow purge and sample method consists of using a submersible pump to purge the well at a very low flow rate (0.5 to 1.5 liter/minute). The pump intake is set approximately in the middle of the well screen, with a stagnant water column over the top of the pump. The well is purged at the low rate until the field parameters (temperature, pH, specific conductivity, turbidity, dissolved oxygen, Eh) have stabilized. The sample is then collected directly from the pump discharge at a low flow rate (see Section 2.2).

2.1 Equipment

The following equipment is required:

- Adjustable rate submersible pump (e.g., Grundfos Redi-Flo₂ with converter)
- Generator
- Teflon-lined polyethylene tubing
- Filtration apparatus with 0.45 um filter
- Polyethylene sheeting
- Monitoring instrument for measuring pH, turbidity, dissolved oxygen, conductivity, temperature (Horiba U-10 or equivalent)
- Eh (oxidation potential) meter (Orion or equivalent)
- Large, wide-mouth breakers for measuring field parameters
- Photoionization detector or equivalent (PID)
- Electronic water level indicator or equivalent (marked in 0.01 foot increments)

- Nylon stay-ties
- Logbook(s)
- Decontamination supplies specified in Section 2.3 of this SOP:
 - steam cleaner
 - three foot length, 3-4" diameter PVC pipe with end cap
 - (alternative) eight - 5 gallon buckets
 - (alternative) potable water supply
 - (alternative)alconox
 - (alternative) methanol
 - (alternative) de-ionized water
- Sample bottles and preservatives specified in the Quality Assurance Project Plan (QAP)
- Labels and shipping products specified in the QAP
- Personal protective equipment specified in Site Health and Safety Plan

2.2 Procedure

The following describes the sampling procedures for the low-flow sampling method. Equipment calibration, logbook documentation, sample bottle filling and preservation, and shipping will all be conducted in accordance with the procedures specified in the QAP. Personal protective equipment will be donned in accordance with the requirements of the Site Health and Safety Plan (HSP). Wells shall be sampled in the order of least contaminated to most contaminated.

- 1) Check and record the condition of the well for any damage or evidence of tampering.
- 2) Remove the well cap.
- 3) Measure well headspace with a PID and record the reading in the field logbook. For wells installed on a landfill, also measure the headspace with a combustible gas indicator.
- 4) Measure and record the depth to water with an electronic water level device and record the measurement in the field logbook. Do not measure the depth to the bottom of the well at this time (to avoid disturbing any sediment that may have accumulated). Obtain depth to bottom information from installation information in the field logbook or drilling logs. Calculate volume of the water column as: depth of water column x cross-sectional area of the well.

- 5) Lay out the polyethylene sheeting and place the monitoring, purging and sampling equipment on the sheeting. To avoid cross-contamination, do not let any downhole equipment touch the ground.
- 6) Re-check and record the depth to water after approximately 5 minutes. If the measurement has changed more than 1/100th of a foot, check and record the measurement again, then begin well purging.
- 7) Attach and secure the teflon-lined polyethylene tubing to the low-flow submersible pump. As the pump is lowered into the well, secure the safety drop cable, tubing, and electrical lines to each other using nylon stay-ties placed approximately 5 feet apart.
- 8) The pump should be set at approximately the middle of the screen. Be careful not to place intake less than 2 feet above the bottom of the well as this may cause mobilization of any sediment present in the bottom of the well. Start pumping the well at 0.5 to 1.5 liters per minute.
- 9) The water level in the well should be monitored during pumping, and ideally the pump rate should equal the well recharge rate with little or no water level drawdown in the well (the water level should stabilize for the pumping rate). There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record the pumping rate adjustments and depth(s) to water in the logbook. If the recharge rate of the well is slow and the well is purged dry, then wait until the well has recharged to a sufficient level and collect the appropriate volume of sample with the submersible pump.
- 10) The well should be purged at a low-flow rate (from 0.5 to 1.5 liters per minute). During purging, monitor the field parameters (temperature, pH, turbidity, specific conductance, dissolved oxygen and Eh) approximately every 3 to 5 minutes until the parameters have stabilized to within 10 percent (plus or minus 5 percent) over a minimum of three readings. Turbidity and dissolved oxygen are typically the last parameters to stabilize. Note: once turbidity readings get below 10 NTUs, then the stabilization range can be amended to 20 percent (plus or minus 10 percent) over a minimum of three readings.

Readings should be taken in a clean container (preferably a less beaker) and the monitoring instrument allowed to stabilize before collection of the next sample. The Horiba instrument takes the readings consecutively and therefore the process to record all the measurements may take longer than five minutes. If so, measurements should be taken as often as practicable.

- 11) Once the field parameters have stabilized, collect the samples directly from the end of the tubing. Volatiles and analytes that degrade by aeration must be collected first. The bottles should be preserved and filled according to the procedures specified in the QAP. All sample bottles should be filled by allowing the pump discharge to flow gently down the inside of the bottle with minimal turbulence. Cap each bottle as it is filled.

- 12) The ratio of "filtered" to "unfiltered" metals will be decided upon based on site conditions and specified in the QAP. The filtered metals samples will be collected into an unpreserved bottle and then filtered with a 0.45 um filter and pumped into a pre-preserved bottle. Document all field procedures used and any pertinent field observations.
- 13) Samples shall be preserved, labelled, and placed immediately into a cooler and maintained at 4°C throughout the sampling and transportation period. Samples should be labeled, recorded on the chain-of-custody, and shipped according to the procedures specified in the QAP.
- 14) The pump assembly should be carefully removed from the well. The teflon-lined polyethylene tubing will be dedicated to each well. The tubing should be placed in a large plastic garbage bag, sealed, and labeled with the appropriate well identification number. The tubing will be stored on-site until the next round of sampling.
- 15) After sampling is complete, measure the total depth of the well.
- 16) Close and lock the well.

2.3 Decontamination

The pump (including support cable and electrical wires which are in contact with the sample) will be decontaminated by the following procedure:

- 1) Steam clean the outside of the submersible pump.
- 2) Pump alconox solution through the inside of the pump. Note: if gross VOC contamination is encountered in the well (e.g., LNAPLs or DNAPLs), then this procedure shall be amended to pumping either methanol, hexane or isopropyl alcohol through the inside of the pump.
- 3) Pump hot water from a steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside 3 or 4 inch diameter PVC pipe with an end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: in order to utilize a steam cleaner jet, it must be certified that no additives or solutions have been added to the steam cleaner jet to prevent corrosion.
- 4) Pump distilled water through the inside of the pump.

All other equipment that comes in contact with contaminated groundwater, and the pump -- as an alternate method, can be decontaminated using the six-step procedure described below:

- 1) Flush the equipment/pump well with potable water
- 2) Flush withalconox solution
- 3) Flush equipment/pump again with potable water
- 4) Flush with methanol
- 5) Flush equipment/pump with de-ionized water
- 6) Allow equipment/pump to air dry.

If this procedure is used to decontaminate the pump, the duration of flushing with de-ionized water shall be sufficiently long to ensure that all methanol has been rinsed out.

Equipment blanks shall be collected at intervals to monitor the decontamination procedures. The specific percentage or number of blanks shall be defined in the QAP.

3.0 RESTRICTIONS/LIMITATIONS

Careful sampling for compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point, is not homogenized and has been disturbed.

4.0 REFERENCES

Draft Sampling Operating Procedures (SOP) Low-Flow Groundwater Sampling for Volatile Oranics and Inorganics at the Davis Superfund Site, correspondence from Joe Lemay (USEPA Region I) to Jeanne Westervelt (Camp Dresser and McKee, Inc.), February 24, 1993.

Puls, R.W. and R.M. Powell. Acquisition of Representative Ground Water Quality Samples for Metals. Ground Water Monitoring Review, Summer 1992.

USEPA, Sampling Procedures for Saco, Maine Superfund Site. Correspondence from Robert W. Puls (R.S. Kerr Environmental Research Laboratory) to R. Willey, (USEPA Region I).

HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM
STANDARD OPERATING PROCEDURE 11
DUPLICATE AND SPLIT SAMPLE PREPARATION

1. OBJECTIVE

The objective of this procedure is to define the requirements for the collection and preparation of duplicate and/or split samples.

2. BACKGROUND

Duplicate and split samples are typically obtained for either of two purposes: (1) as a means of quality control (QC) from the point of sample collection through all analytical processes (if the initial and duplicate samples are not within specification, the reasons for the discrepancy must be found and corrected, if possible) or (2) for later laboratory analyses, if needed.

Duplicate samples are samples collected from a location as close to the primary sample location as possible. They are collected to provide a means of assessing the reliability of field sampling methods and analytic data resulting from field samples.

Split samples are normally obtained for the express purpose of submitting identical samples to different laboratories for comparative analytical results. None may be required if the lead laboratory has adequate internal quality assurance (QA)/QC. Duplicate and/or split samples may be collected as composite or grab samples from most media or waste types.

Basically the same equipment and techniques outlined in Hazardous Waste Remedial Actions Program (HAZWRAP) Standard Operating Procedures (SOPs) 5, 7, 8, and 9 will be required when obtaining duplicate and/or split samples. Briefly, the sampling requirements are: (1) grab samples will be collected for surface soil, surface water, groundwater sediment, and sludge, destined for volatile organic compound (VOC) analysis, and composite or grab sampling techniques can be used for non-VOCs; and (2) for subsurface soils, sectioned liner (brass) samples for VOCs and composite samples for non-VOCs.

Comparative analyses between laboratories can also be obtained from semivolatile organic compounds and/or metals. Duplicate samples can also be obtained for VOC and non-VOC contaminated media by careful grab samples and/or selective use of the appropriate liner. For most split or duplicate sampling for non-VOC parameters, in all media, compositing is recommended.

3. RESPONSIBILITIES

Site Manager: The Site Manager will ensure that sampling efforts are conducted in accordance with this procedure and other SOPs pertaining to specific media sampling.

Project Field Geologist: The Project Field Geologist is responsible for ensuring that field personnel collect split and duplicate samples in accordance with this and other relevant procedures.

Project QA/QC Manager: The Project QA/QC Manager is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of split and duplicate samples collected meet the requirements of the Project QA/QC Plan.

4. REQUIRED EQUIPMENT

The equipment required to obtain duplicate and/or split samples is identical to that for other media sampling. Refer to HAZWRAP SOPs 5, 7, 8, and 9 for specifics.

5. PROCEDURES

5.1 DUPLICATE SAMPLES

The following steps must be followed when collecting duplicate samples:

1. Determine the frequency of obtaining duplicate samples as specified in the site-specific sampling plan.
2. Proceed with site sampling to the point that a duplicate sample is required.
3. The duplicate sample is a sample taken at the same time, as close as possible, and under the exact conditions as those required for the primary sample. NOTE: Any sample or portion of a sample that is to be analyzed for VOCs shall be collected and contained immediately. Do not stir, mix, or agitate samples for VOC analysis before containment.
4. Follow the specific media sampling plan outlined in HAZWRAP SOPs 5, 7, 8, and 9. The preparation and disposition of the duplicates will be the same as those for the primary samples.
5. Obtain VOC samples first (without mixing or compositing), then proceed to Step 6. Mix all non-VOC duplicate samples as detailed in HAZWRAP SOP 12 or when taking duplicates of surface water or groundwater samples. Mixing may be

accomplished by pouring a portion of the sample directly from the sampling device into the original container, and then pouring an equal portion into the duplicate container, alternating between the two until the sample containers are full.

6. Place the sample(s) in the appropriate sample container. Duplicate samples will be labeled/or tagged according to their intended use as detailed in the sampling plan. If the sampling plan duplicates are to be held for possible later analyses, they may be labeled as "sample XXX duplicate," where the number "XXX" refers to the primary sample. If the duplicates are intended for QC measures, they may be given discrete sample numbers. Duplicate samples must be properly identified in the field logbook.
7. Sealed, pack, and transport duplicate samples in the same manner as that used for other samples from the sampling site.
8. Decontaminate all equipment according to HAZWRAP SOP 14. Place all disposable liquids and solids in the appropriate receptacles.
9. Remove personnel protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.

5.2 SPLIT SAMPLES FOR SURFACE SOILS, SEDIMENTS, AND SLUDGES

The following steps must be followed when collecting split samples of surface soils, sediments, and sludges:

1. Determine the number and frequency of required sample splits as specified in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media sampling procedure outlined in HAZWRAP SOP 7 or 8.
4. NOTE: Split samples for VOCs are not recommended. Adequate cross-laboratory checks can be obtained by splits of non-VOC samples. If QA is required for VOC samples, obtain duplicates as outlined in Sect. 5.1 of this SOP. All split samples for VOC analysis for the above media are grab samples taken as specified in Step (3), Sect. 5.1 of this SOP.
5. For non-VOC grab samples, obtain a sufficient volume to fill all required sample containers, including those required for splits.
6. Composite these samples according to HAZWRAP SOP 12.
7. Split the composite sample equally and place the required volumes into the sample containers.
8. Seal and decontaminate the outside surfaces of the containers.
9. Label split samples as specified in the site sampling plan. Record all pertinent information in the field logbook.
10. Split samples will be sealed, packed, and transported in an identical manner as that specified for other samples from the site. The difference may be their destination

(different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.

11. Decontaminate all equipment according to HAZWRAP SOP 14. Place all disposables in the appropriate receptacles.
12. Remove protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.

5.3 SPLIT OR DUPLICATE VOLATILE ORGANIC COMPOUND SAMPLING OF SUBSURFACE SOILS WITH SPLIT SPOONS OR SHELBY TUBES

The following steps must be followed when sampling subsurface soils with split spoons or Shelby tubes:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media sampling plan outlined in HAZWRAP SOP 9.
4. For VOC samples, place four liner sections within the split-spoon barrel. Each liner section is to be sized to obtain at least one-half the volume necessary for a soil VOC sample. NOTE: Most split-spoon sampling in the field is accomplished with 2-in. OD split spoons. When split or duplicate samples are required, a 2-in. OD split spoon will usually not collect sufficient sample volume if a number of analytes are to be sampled. In such situations, it is advisable to follow the American Society for Testing Materials (ASTM) D-1584 modified method of split-spoon sampling using a 300-lb drop hammer and a 3-in. OD split spoon. If blow counts are not required for engineering purposes, and the site soils permit, attempts may be made to drive the 3-in. split spoon by the 140-lb weight. This deviation will ensure collection of enough sample volume. Additional liner sections for non-VOC samples may also be placed within the split spoon.
5. Liner sections intended for VOC sample collection should be identified with the letters A through D or any other distinctive identification scheme. In homogeneous soils, stack the liner sections in alphabetic order from the bottom of the split-spoon barrel. For heterogenous (stratified soils), sampling plans may call for alternating VOC and non-VOC liner sections.
6. For VOC analysis and upon retrieving the split spoon, liner section A is immediately capped and sealed on-site and becomes the original sample. Liner B is also immediately capped and sealed. It becomes the duplicate sample. Liner sections C and D may be composited for all other non-VOC analysis. For compositing procedures, see HAZWRAP SOP 12.
7. Decontaminate the outside of the sample container after sealing.

8. Label split samples as specified in the site sampling plan. Record all pertinent information in the field logbook.
9. Split samples will be sealed, packed, and transported in an identical manner as other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site sampling plan specifies the disposition of split samples.
10. Decontaminate all equipment according to HAZWRAP SOP 14. Place all disposables in the appropriate receptacles.
11. Remove protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free upon leaving the sampling site.

5.4 SPLIT OR DUPLICATE NON-VOLATILE ORGANIC COMPOUNDS SAMPLING OF SUBSURFACE SOILS WITH SPLIT SPOONS OR SHELBY TUBES

The following steps should be followed when sampling subsurface soils with split spoons or Shelby tubes:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s). For non-VOC subsurface soil samples, liners are not required and all material retrieved by the split spoon should be composited.
3. Follow the specific media sampling procedure outlined in HAZWRAP SOP 9.
4. Composite the sample according to HAZWRAP SOP 12. (NOTE: Most split-spoon sampling in the field is accomplished with 2-in. OD split spoons. When split or duplicate samples are required, a 2-in. OD split spoon will usually not collect sufficient sample volume if a number of analytes are to be sampled. In such situations, it is advisable to follow the ASTM D-1584 modified method of split-spoon sampling using a 300-lb drop hammer and a 3-in. OD split spoon. This deviation will ensure collection of enough sample volume. Portion the samples, including splits, to sample containers as directed by the site-specific sampling plan.)
5. Seal sample containers and decontaminate outside surfaces.
6. Label split samples as specified in the site sampling plan. Record all pertinent information in the field logbook.
7. Split samples will be sealed, packed, and transported in a manner identical to that for other samples from the site. The difference may be their destination (different laboratories) and extent of analytical work. The site sampling plan specifies the disposition of split samples.
8. Decontaminate all equipment according to HAZWRAP SOP 14. Place all disposables in the appropriate receptacles.
9. Remove personnel protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.

5.5 SPLIT SAMPLES FOR SURFACE WATER AND GROUNDWATER

The following steps must be followed when collecting split samples for surface water and groundwater:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media sampling procedure outlined in HAZWRAP SOP 5, 7, or 8.
4. Split samples for VOCs are not recommended. Adequate cross-laboratory checks can be obtained by splits of non-VOC samples. If QA is required for VOC samples, obtain duplicates as outlined in Sect. 5.1 of this SOP. All split samples for VOC analysis for the above media are grab samples taken as specified in Step (3), Sect. 5.1 of this SOP.
5. For non-VOC grab samples, obtain a sufficient volume to fill all required sample containers, including those required for splits.
6. Obtain VOC samples first (without mixing or compositing). Mix all non-VOC duplicate samples as detailed in HAZWRAP SOP 12 or when taking duplicates of surface water or groundwater samples. Mixing may be accomplished by pouring a portion of the sample directly from the sampling device into the original container, and then pouring an equal portion into the duplicate container, alternating between the two until the sample containers are full.
7. Split the composited sample by placing the required volumes in the sample containers, including those for split samples.
8. Seal and decontaminate the outside surfaces of the containers.
9. Label split samples as specified in the site sampling plan. Record all pertinent information in the field logbook.
10. Split samples will be sealed, packed, and transported in a manner identical to that for other samples from the site. The difference may be their destination (different laboratories) and extent of analytical work. The site sampling plan specifies the disposition of split samples.
11. Decontaminate all equipment according to HAZWRAP SOP 14. Place all disposables in the appropriate receptacles.
12. Remove personnel protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.

6. RESTRICTIONS/LIMITATIONS

Samples requiring VOAs must be collected and contained immediately. Agitation by mixing, stirring, or shaking will cause vaporization of the volatile fraction to a significant degree. Resample if agitation has occurred.

7. REFERENCES

- U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.
- U.S. Environmental Protection Agency, *Data Quality Objectives for Remedial Response Activities*, EPA/540/G-87/003, 1987.
- U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540P-87/001, 1987.

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SOP-FL-005
CHAIN-OF-CUSTODY PROCEDURES

1.0 INTRODUCTION

This section describes the procedures used to ensure that sample integrity and chain-of-custody are maintained throughout the sampling and analysis program. Chain-of-custody procedures (COC) provide documentation of sample handling from the time of collection until its disposal by a licensed waste hauler. This documentation is essential in assuring that each sample collected is of known and ascertainable quality.

The chain-of-custody begins at the time of sample collection. Sample collection is documented in the field notebooks in accordance with the specified SOP. At the same time, the sampler fills out the label on the sample container with the following information:

- Sample ID code
- Sampler initials
- Date and time of sample collection

A "Chain-of-Custody Record" form is filled out for each sample type at each sampling location. Each time the samples are transferred to another custodian or to the laboratory, the signatures of the people relinquishing the sample and receiving the sample, as well as the time and date, are documented. Labels will be filled out with an indelible, waterproof, marking pen.

A sample Chain-of-Custody Record is shown in Figure 1. The actual chain-of-custody record is a three part form. The original form is retained by the laboratory. The person relinquishing the samples keeps a copy of the form at the time of sample submittal. This form is then returned to the site manager or person in charge of data coordination.

The Chain-of-Custody Record will be placed in a Ziplock bag and placed inside of all shipping and transport containers. All samples will be hand delivered or shipped by Federal Express to the laboratory specified by the Sampling and Analytical Coordinator. Samples should be packed so that no breakage will occur.

SOP-FL-001
FIELD LOG BOOK CONTENT

1.0 INTRODUCTION

Information recorded in field log books include observations, data, calculations, time, weather, description of the data collection activity, methods, instruments, and results. Additionally, the log book may contain descriptions of wastes, biota, geologic material, and site features including sketches maps, or drawings as appropriate.

2.0 PREPARATION

In addition to this SOP, site personnel responsible for maintaining log books must be familiar with other pertinent SOPs. These should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office.

Prior to use in the field, each log book should be marked with a specific control number. The field notebook will then be assigned to an individual responsible for its care and maintenance.

Field log books shall be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the log book. The following information shall be recorded inside the front cover of the log book:

- Field log book document number
- Activity (if the log book is to be activity-specific)
- Person and organization to whom the book is assigned, and phone number(s)
- Start date

The first five pages of the log book shall be reserved for a table of contents. Mark the first page with the heading and enter the following:

TABLE OF CONTENTS

Date/Description	Page
(Start Date)/Reserved for TOC	1-5

The remaining pages of the Table of Contents will be designated as such with "TOC" written on the top center of each page.

3.0 OPERATION

The following is a list of requirements that must be followed when using a log book:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the log book. If data-collection forms are specified by an activity-specific plan, this information need not be duplicated in the log book. However, any forms used to record site information must be referenced in the log book.
- Do not start a new page until previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Before an entry has been signed and dated, any changes may be made but care must be taken not to obliterate what was written originally. Indicate any deletion by a single line through the material to be deleted.
- Do not remove any pages from the book.
- Record as much information as possible.

Specific requirements for field log book entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the log book by inserting the following:

Above notes authored by:

- (Sign name)
- (Print name)
- (Date)

- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
 - Date and time
 - Name of individual making entry
 - Description of activity being conducted including station (i.e., well, boring, sampling location number) if appropriate
 - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
 - Level of personnel protection to be used

Entries into the field log book shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the log book must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the log book should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is towards the top of the page.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, down-time, or delays.
- Upgrade or downgrade of personnel protection equipment.

4.0 POST-OPERATION

To guard against loss of data due to damage or disappearance of log books, copies of completed pages shall be periodically (weekly, at a minimum) and securely stored at the field office. Documents which are separated from the log book shall be copied and submitted regularly and as promptly as possible to the field office. This includes all automatic data recording media (print-outs, logs, disks or tapes) and activity-specific data collection forms required by other SOPs.

At the conclusion of each activity or phase of site work, the individual responsible for the log book will ensure all entries have been appropriately signed and dated, and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed log book shall be submitted to the field office records file.

5. REFERENCES

Sandia National Laboratories. 1991. Procedure for Preparing, Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures, QA-02-03. Albuquerque Environmental Program Department 3320. Albuquerque, New Mexico.

Sandia National Laboratories. 1992. Division 7723. Field Operation Procedure for Field Logbook Content and Control. Environmental Restoration Department. Albuquerque, New Mexico.

Appendix D

Field Equipment Operation and Maintenance Procedures

- Thermo Environmental 580B Photoionization Detector
- YSI Model 33 Conductivity Meter
- Orion SA250 pH/Eh/Temperature Meter
- LaMotte Turbidity Meter

SOP-IN-001 PHOTOIONIZATION DETECTOR

1.0 INTRODUCTION

This Standard Operating Procedure (SOP) is specific to the HNu PI 101 and the Thermal Environmental Organic Vapor Monitor Photoionization Detectors (PID). These portable instruments are designed to measure the concentration of trace gases in ambient atmospheres at industrial and hazardous waste sites and are intrinsically safe. The analyzers employ photoionization detectors.

The PID sensor consist of a sealed ultraviolet light source that emits photons which are energetic enough to ionize many trace species (particularly organics) but do not ionize the major compounds of air such as O_2 , N_2 , CO , CO_2 , or H_2O . An ionization chamber adjacent to the ultraviolet lamp source contains a pair of electrodes. When a positive potential is applied to one electrode, the field created drives any ions, formed by absorption of UV light, to the collector electrode where the currents (proportional to concentration) are measured. One major difference between a flame ionization detector (FID) and a PID is that the latter responds to inorganic compounds as well as non methane type organic compounds.

To assess whether the instrument will respond to a particular species, the ionization potential (IP) should be checked. If the IP is less than the lamp energy, or, in some cases, up to 0.2-0.3 electron volts (ev) higher than the lamp energy, instrument response should occur. For example, hydrogen sulfide (IP = 10.5 ev) may be detected with a 10.2 ev lamp, but butane (IP 10.6 ev) will not be detected.

2.0 CALIBRATION

Calibration of all CDM field equipment is performed by qualified personnel trained in calibration techniques for all field items. When a field instrument which requires calibration is obtained from the equipment room, the unit will display a calibration tag denoting the date when the instrument was last calibrated and/or maintained. All field instruments are calibrated each time they leave the equipment facility for a site. A maintenance file is kept for each calibrated field item.

PID and FID detector type instruments come with field calibration kits. A field calibration kit would be used if the instrument is to be kept out at the site for extended periods of time, or if the instrument endures prolonged environmental extremes. In either case, a calibration check standard could be introduced in the instrument to verify it's accuracy. If an instrument will not calibrate or shows improper field operation, it should be sent back to the office, and another instrument reissued. Field personnel should not try to maintain the instruments in the field. If long sampling program is required, be prepared to take more equipment for backup in case of instrument failure. Records and procedures of all calibration techniques are on file at the CDM equipment management facility in Ten Cambridge Center, Cambridge, Massachusetts.

With the instrument fully calibrated, it is now ready for use. Any results obtained should be reported as parts per millions (ppm) as isobutylene. If you need to convert these numbers based on a benzene standard, HNu offers a conversion table which is available from CDM. Important instrument specifications for each PID detector are listed as follows.

HNu PI 101 Performance

range - 0.1 to 2000
detection limit 0.1 ppm

OVM Model 580A

0 - 2000
0.1 ppm

HNu PI 101 Power Requirements

- continuous use, battery > 10 hours
- recharge time, max > 14 hours, 3 hours +
- NiCd Battery

OVM Model 580A

8 hours
8 hours
Gel Cell Battery

- Unit can be operated on battery charger.
- Both units provide protection circuitry for the battery. This prevents deep discharging of the battery and considerably extends the battery life.

3.0 HNU PI 101

3.1 Procedure

- 1) Before attaching the probe, check the function switch on the control panel to make sure it is in the off position. The 12 pin interface connector for the probe is located just below the span adjustment on the face of the instrument. Carefully match the slotted groove on the probe to the raise slot on the 12 pin connector on the control panel. Once in line, twist the outer ring on the 12 pin connector until it locks into position (a distinct snap noise will be felt when in place).
- 2) Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scaleplate. The battery, if needle falls below the green arc, should be recharged before any measurements are taken. If the read LED on the instrument panel should come on, the battery needs charging and the unit cannot be operated without a charger.
- 3) If the battery is functioning properly, turn the function switch to the STANDBY position. If the needle on the instrument does not read 0, then turn the knob on the instrument panel until the needle deflects to the zero point on the meter.
- 4) Once the zero is confirmed, turn the function switch to the 0-20 position. At this point, the needle will read approximately 0.5-ppm. This reading is normal background for ambient air. For CDM health and safety reasons, the HNU PI 101 should be operated on this range to insure maximum

sensitivity in the work area. The unit, however, has 2 other ranges (0-200), (0-2000) should monitoring be required for other purposes such as headspace analysis etc. where readings could exceed the 0-20 ppm range.

3.2 Limitations

- 1) AC power lines (high tension lines), or power transformers can interfere with the instruments performance. This situation can be confirmed by noting a deflection of the meter while in the STANDBY position.
- 2) Environmental factors such as humidity, rain and extreme cold can limit the instruments performance. To verify the "water sensitivity" condition, gently blow in the hole at the end of the probe. If the needle deflects positively (on the 0-20 position) by 2 ppm or more, a water sensitivity problem exists and the unit should be brought into the warehouse for service. HNU PI 101 should be kept out of the rain as much as possible or covered. This will insure longer operating times with less false positive readings.
- 3) Quenching the detector can limit the instruments performance. This occurs when a compound such as methane at a very high concentration is introduced to the detector. The concentration is so high that the unit does not respond at all or gives a negative reading.

4.0 OVM 580A

4.1 Procedures

- 1) With the unit being fully calibrated before receiving it, you are ready for operation. Located on the right hand side of the unit is a panel. Slide this panel off of the unit. Inside there is a switch which supplies power to the LCD portion of the instrument. Turn this switch on and replace the panel. On the top of the OVM, there is an instrument panel. Locate the on/off switch and turn the unit on. This switch activates the lamp as well as the pump. Turn this switch off when the instrument is not in use, but leave the internal switch on.
- 2) The unit is now in the operation mode with all readings shown on the LCD display. Options for the OVM 580A include automatic recording and alarm settings. Should any options be required, they can be set up before the instrument leaves the CDM equipment warehouse.

Warning signals associated with the OVM include a Low Battery signal. A flashing B will appear in the left hand corner of the bottom line of the display when the 580A is in the RUN mode. If a gas concentration >2000ppm is detected by the OVM, the top line of the display will show OVERRANGE. Once this occurs, the instrument will "lock out" until the unit is brought to a clean area. A clean area is described as an area where the concentration of organic vapors is below 20 ppm.

SOP-IN-010 CONDUCTIVITY METER

1.0 INTRODUCTION

Conductivity is a numerical expression of the ability of an aqueous solution to carry an electrical current. This ability depends on the presence of ions in the solution, and their total concentration. Factors such as mobility valence, relative concentration, and temperature also combine to create this occurrence. Solutions of most inorganic acids, bases and salts are relatively good conductors. Organic compounds in aqueous solutions are not good conductors. For example, freshly distilled water has conductivity reading of .5 to 2 mhos/cm and increases with time. This increase is caused by absorption of atmospheric carbon dioxide, and to a lesser extent ammonia. While industrial type wastes have conductivity readings of 10,000 \pm mhos/cm.

2.0 MODEL SCT PROCEDURES

The model 33 SCT has 3 conductivity scales of 0-500, 0-5000, and 0-50,000 mhos/cm. Salinity is scaled 0-40 parts per thousand in a temperature range of -2 to +45°C. Temperature is scaled -2° to +5°C.

With the instruments calibration verified, the unit is now ready for use. The model 33 S-C-T meter face is scaled and calibrated to give an accurate reading of the conductivity of a water sample by measuring the amount of current flow between two fixed electrodes in the probe. The unit also measures salinity in a special range conductivity circuit, which includes a user-adjusted temperature compensator. A precision thermistor in the probe measures temperature by changing its resistance in relation to the temperature of the water.

The start-up procedure is as follows:

- 1) Plug the probe plug receptacle in the side of the meter.
- 2) With the mode select in the OFF position, check to see that the meter needle is centered at the zero mark on the conductivity scale and adjust if necessary.
- 3) Turn the mode control switch to Red Line position.
- 4) Adjust the Red Line control knob so the meter needle lines up with the red line on the meter face. If this cannot be accomplished, replace the batteries. If battery replacement is necessary, use only alkaline "D" cells as regular carbon zinc batteries will cause errors.
- 5) Place the probe into the solution to be measured.
- 6) Set the mode control to TEMPERATURE. Read the temperature on the bottom scale of the meter in °C. Allow time for the probe temperature to come to equilibrium before taking a reading.

- 7) With the probe in the solution to be tested, adjust the conductivity scale until the meter reading is on scale. (Multiply the reading by the correction on the calibration sticker on the instrument).
- 8) When using the X10 and X100 scales, depress the CELL TEST button. If the reading on the dial moves $\pm 2\%$, the electrode is fouled and needs to be cleaned. Repeat the measurement on another instrument.
- 9) Store the probe in distilled water when not in use.

SOP-IN-009 pH METER

1.0 INTRODUCTION

pH is the negative logarithm of the effective hydrogen ion concentration (or activity) in gram equivalents per liter used. This expresses both acidity, and alkalinity on a scale whose values run from 0 to 14. Number 7 represents neutrality, and numbers greater than 7 indicate increasing alkalinity while numbers less than 7 indicate increasing acidity. pH is one of the most commonly analyzed parameters. Water supply treatment such as neutralization, softening, disinfection and corrosion control are all pH dependent. CDM has a variety of pH monitoring instruments in the equipment warehouse.

2.0 ORION SA 250 pH PROCEDURES

With the instrument fully calibrated, it is now ready for use. Follow the check out procedures:

- 1) Slide power switch to on position. Attach BNC shorting plug to BNC connector on top of meter.
- 2) If LO BAT indicator on LCD remains on, the battery must be replaced.
- 3) Slide mode switch to mv. Display should read $0 \pm .3$.
- 4) Slide mode switch to TEMP. Display should read 25.0. If 25.0 is not displayed, scroll using, and X10 keys, until 25.0 is displayed and press enter.
- 5) Slide mode switch to pH .01. Press iso. Display should read the letters ISO, then a value of 7.000. If 7.000 is not displayed, scroll until 7.00 is displayed and press enter.
- 6) Press slope. Display should read the letters SLP, then a value of 100.0. If 100.0 is not displayed, scroll until 100.0 is displayed and press enter.
- 7) Press sample. Observe the letters pH, then a steady reading of 7.00, ± 0.02 should be obtained. If not, press CAL and scroll until 200 is displayed and press enter. Press sample and observe a reading of 7.00.
- 8) Remove the shorting plug. After completing these steps, the meter is ready to use with an electrode.
- 9) Attach electrodes with BNC connectors to sensor input by sliding the connector onto the input, pushing down and turning clockwise to lock into position. Connect reference electrodes with pin tip connectors by pushing connector straight into reference input.
- 10) Put the temperature probe in the sample and let it stabilize.

- 11) Once temperature is stable, set the unit to read pH (by 0.1 or 0.01) and take a reading in the aqueous sample. (Remembering first to remove the cap on the end of the pH probe.)

3.0 MODEL TRIPAR ANALYZER PROCEDURES

With the instrument fully calibrated, it is now ready for use:

- 1) Connect the pH probe's BNC input connector to the front of the Tripar.
- 2) Put the pH/mv switch on the pH position.
- 3) Turn the parameter display selection switch to TEMP.
- 4) Plug in the gray temperature plug jack in the input temperature sensor connector.
- 5) Put end of temperature probe in the sample.
- 6) Allow the temperature to stabilize.
- 7) Turn the temperature compensation knob to the temperature shown.
- 8) Turn the parameter display selection switch to pH.
- 9) Put pH probe in the aqueous sample (remembering first to remove the cap on the end of the probe). Let it stabilize and record the reading.

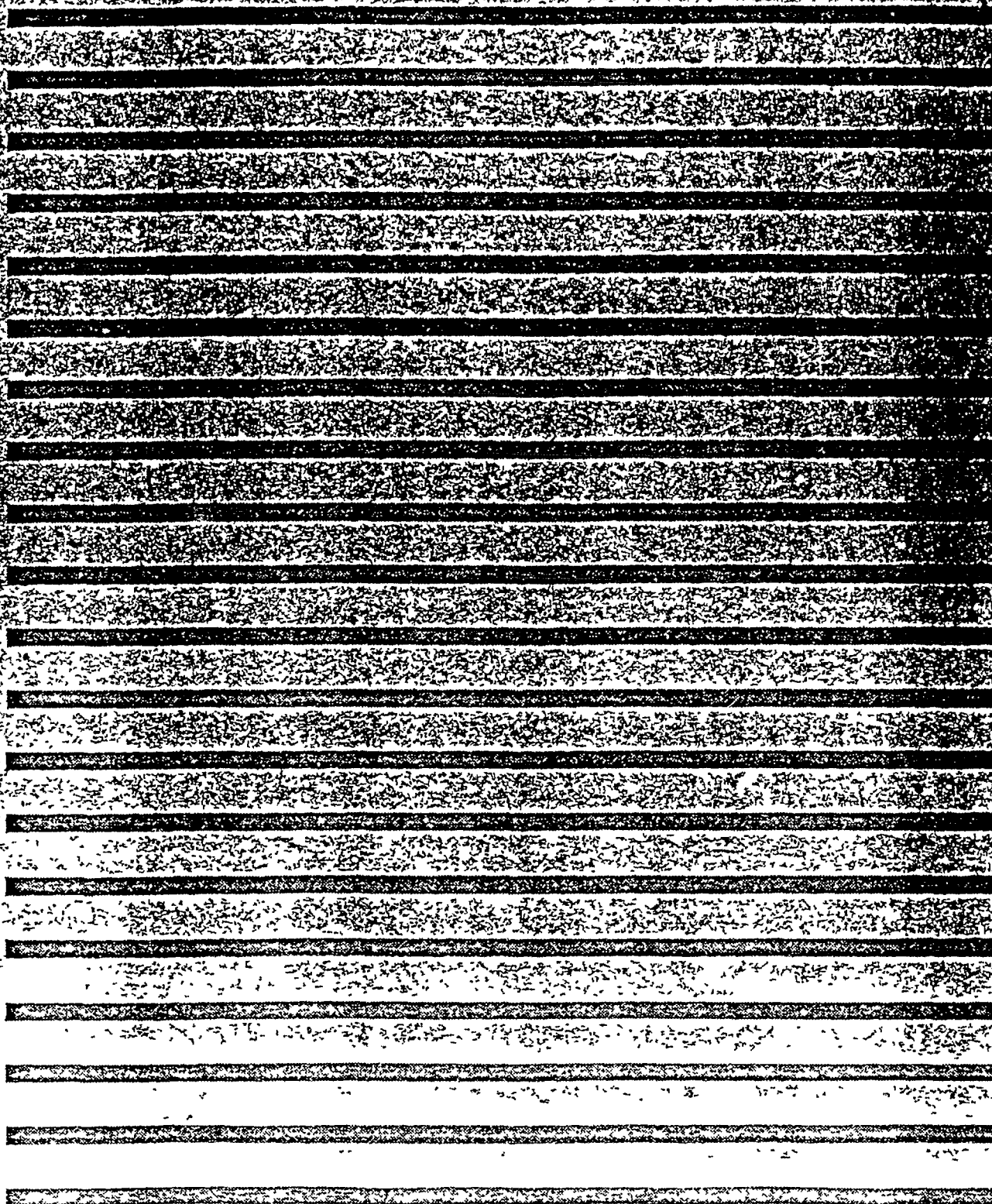


TURBIDIMETER

OPERATOR'S MANUAL

MODEL 2008

CODE 1730



GENERAL OPERATING INSTRUCTIONS

The accuracy and repeatability of your measurements will be a function of the condition of your standards, your technique, and the quality of the glassware.

STANDARDS

Two standards are supplied with each 2008, and others are available. The standards are used as a reference to allow you to calibrate, or *Standardize*, the instrument. This typically would be done before a series of measurements, or on some other regular basis, as an assurance of the accuracy of your readings. The AMCO™ standards supplied have been carefully manufactured and are guaranteed to be accurate to within $\pm 1\%$. Since the accuracy of your results will depend on these standards the following observations and precautions are important:

1. In an unopened bottle (as supplied) the standards will remain stable indefinitely as long as they are not exposed to excessively hot or cold environments. (Keep between 10°C and 40°C.)
2. Once the seal is broken on the standard, the stability is only guaranteed for nine months thereafter, again based on normal environmental conditions.
3. To ensure the accuracy of the standard, never transfer anything into the bottle (e.g. don't dilute, don't return standards that have been removed, don't combine with other standards, etc.)
4. Do not open the standards in dusty environments, and guard against contaminants entering the bottle while it is open.
5. When transferring the standard to a sample tube be certain that the tube is absolutely clean. A reasonable precaution is to rinse out the inside of the tube with the standard before filling the tube. This wastes a few mL of standard, but will minimize the possibility of contamination.
6. After transferring the standard, promptly cap both the sample tube and the standards bottle.

TECHNIQUE

The handling of the sample tubes and the preparation of the sample is of utmost importance. The glassware must be clean and defect-free. Scratches and/or abrasions will permanently affect the accuracy of your readings.

A good procedure to follow is the following:

1. Use a clean container to obtain a sample of the liquid to be measured. The volume is not critical; somewhere between 50 and 500 mL is fine. Set the container aside and allow the sample time to equilibrate to ambient temperature, and also to allow any entrained gasses to escape. Keep dust or other airborne contaminants from contact with the sample.
2. When the sample has equilibrated, pour a bit of it into the sample tube as a final rinse, and again shake the excess liquid out. Now fill the sample tube to its neck (See Figure 2), taking care to pour the sample gently down the side to avoid creating any bubbles.
3. Cap the tube and, while holding the tube by the cap only, wipe the outside surface with a clean, lint-free, absorbent wipe until the tube is dry and smudge-free. Handling the tube only by its cap will avoid problems from fingerprints. Set the tube aside on a clean surface that won't contaminate or scratch the bottom of the tube.
4. Select the appropriate range on the 2008, and insert a sample tube containing an AMCO™ standard with a value close to what you suspect the sample you are measuring to be.

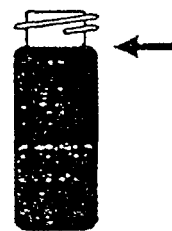


Figure 2

5. Be certain the chamber is capped, and that the tube is seated at the bottom of the chamber. The green front panel LED must be illuminated, indicating that the lamp is on. Adjust the *Standardization* control so that the display reads the known value of the chosen standard.
6. Withdraw the standard and insert the tube with the sample to be measured. Again, make sure the chamber is capped and the tube is seated on the bottom. The reading should stabilize within 15 seconds. Make a note of the reading and withdraw the tube.
7. If you wish to take repeated measurements or measure several samples in succession, it will not be necessary to readjust the *Standardization* before each reading. Once set it will remain stable for long periods. Of course, you may reinsert the standard at any time to verify the stability of the readings.

GLASSWARE

The variability in the geometry and quality of the glassware is the predominate cause of variability in the readings that will be obtained. With a few precautions to minimize the effects of these variations, readings significantly more accurate than the specified $\pm 2\%$ may be obtained.

No piece of glassware is ever perfectly cylindrical (or exactly like any other). You will notice that if the tube is rotated in the chamber slightly (say in 15° increments) the reading will also vary somewhat. If the tube were always placed into the chamber with the same orientation this source of variability could be eliminated. This can be accomplished if the cap is marked in some way, perhaps with a piece of tape, and always used with the same tube. When inserting the tube with its paired cap you can observe the mark on the cap and always insert it with the same orientation. It is especially useful to do this with the tube used for the AMCO™ standards; any variability in the standardization will affect all subsequent readings.

Once the rotational variability is compensated for the residual uncertainty is a result of how well the tubes match. If absolute accuracy is necessary in your readings it is possible to calibrate the set of tubes supplied with the 2008. The procedure entails filling all the tubes with the same sample, preferably a sample with a turbidity at the upper end of the range you will normally use, and recording the readings for each tube. The value of the readings are irrelevant, but they can be used to derive a correction factor for each tube relative to any other tube. However, if monitoring trends and following small changes is more of a concern, the simple precaution of always using the same tube (in the same orientation) will effectively eliminate the $\pm 2\%$ uncertainty. This assumes, of course, that the tubes used for the AMCO™ standards are not switched either.

Following these precautions can allow the precision and repeatability of your readings to approach ± 0.1 NTU. Do not forget, however, that since the standardization procedure is based on the AMCO™ standard used, no reading can be considered to be more accurate than $\pm 1\%$ in an absolute sense.

Appendix E

Data Validation Checklists and Data Qualifiers

ORGANIC DATA COMPLETENESS CHECKLIST

_____ Case Narrative

Quality Control Summary Package

- _____ Surrogate Recovery Summary
- _____ MS/MSD Summary
- _____ Reagent Blank Summary

Sample Data Package

- _____ Holding Times
- _____ Organic Analysis Data Sheets
- _____ GC/EC Chromatograms
- _____ Quantitation Reports

Standards Data Package

- _____ Current List of Laboratory/Instruments Detection Limits
- _____ Initial Calibration Data for each instrument
- _____ Continuing Calibration Data for each instrument
- _____ VOA Standards Quantitation Reports
- _____ VOA Standard Chromatograms and Data System Printouts

Raw QC Data Package

- _____ Reagent Blank Data
 - _____ Organic Analysis Data Sheets
 - _____ Quantitation Reports
 - _____ GC and Data System Printouts
 - _____ Matrix Spike and Matrix Spike Duplicate Data
 - _____ Organic Analysis Data Sheets
 - _____ Chromatograms
 - _____ Quantitation Reports
 - _____ GC Data System Printouts

EXPLANATION OF ORGANICS AND DATA QUALIFIERS

For the purposes of this data review document the following code letters and associated definitions are provided:

- U - The material was analyzed for, but was not detected. The associated numerical value is the estimated detection limit.
- R - Quality Control indicates that data is not usable (i.e., compound may or may not be present). Resampling and re-analysis are necessary to determine the presence or absence of the analyte in the sample.
- UJ-B - The compound is considered to be undetected and the value reported is an estimated detection limit because the compound was identified in the laboratory blank as well as in the sample. The value of this reported detection limit (DL) is determined by the amount of the compound found in the sample:
 - 1) The sample value was less than the MDL: the DL is reported as equal to the MDL.
 - 2) The sample value was greater than MDL but less than 4X the amount of the compound found in the laboratory blank (less than 10X for methylene chloride, acetone, 2-butanone, toluene, and phthalates): the DL is reported as equal to the reported sample value.
 - 3) The sample value was greater than 5X the laboratory blank value (10X for compounds noted above): see JB qualifier.
- J-B - The reported value is an estimated amount. The compound was detected in the blank and quantity reported in the sample is greater than 4X the amount found in the blank (greater than 10X for compounds noted above).
- J - The associated numerical value is an estimated quantity because the amount detected is below the required detection limits or because quality control criteria were not met. (See qualifiers listed below).
- J-N - Tentative identification of a compound. Resampling and reanalysis are necessary for verification.
- J-E - The value reported was estimated due to interference problems.
- J-C - The value reported was estimated due to instrument calibration problems.
- J-H - The value reported was estimated due to holding time violation.
- J-S - The value reported was estimated due to surrogate or matrix spike recovery problems.

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